DISSERTATION ON

"CARTILAGE TYMPANOPLASTY- A REVIEW ON ITS POSTOPERATVE HEARING/FUNCTIONAL OUTCOMES"

Dissertation submitted in partial fulfillment of the regulations for the award of the degree of

M.S.DEGREE BRANCH - IV
OTORHINOLARYNGOLOGY

UPGRADED INSTITUTE OF OTORHINOLARYNGOLOGY
MADRAS MEDICAL COLLEGE
CHENNAI – 600003

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI

APRIL 2016

BONAFIDE CERTIFICATE

This is to certify that this dissertation is a bonafide record of work done by **DR. LOURDES ALBINA.S.A** on **"CARTILAGE TYMPANOPLASTY - A REVIEW ON ITS POSTOPERATVE HEARING/FUNCTIONAL OUTCOMES".** During her **M.S. ENT** course from **April 2014 to April 2016** at the Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai. She is appearing for her M.S. Branch – IV Degree Examination in April –2016 and her work has been done with partial fulfillment of the regulations of The TamilNadu Dr. M.G. R Medical University, Chennai. I forward this to The TamilNadu Dr. M.G. R Medical University, Chennai, TamilNadu, India.

GUIDE :

PROF. Dr.M.K.RAJASEKAR, M.S.,D.L.O.,
Professor of ENT,
Upgraded Institute of Otorhinolaryngology,
Madras Medical College,
Rajiv Gandhi Govt. General Hospital,
Chennai – 600003

THE DIRECTOR i/c & PROFESSOR
Dr. R.MUTHUKUMAR, MS., DLO., DNB.,
Upgraded Institute of Otorhinolaryngology,
Madras Medical College,
Rajiv Gandhi Govt. Gen Hospital,
Chennai – 600003

THE DEAN
Madras Medical College,
Rajiv Gandhi Govt. Gen. Hospital,
Chennai – 600003

DECLARATION

I, **DR.LOURDES ALBINA.S.A**, solemnly declare that this dissertation entitled "**CARTILAGE TYMPANOPLASTY-A REVIEW ON ITS POSTOPERATVE HEARING / FUNCTIONAL OUTCOMES"** is a bonafide work done by me in Upgraded Institute Of Otorhinolaryngology, Madras Medical College and Rajiv Gandhi General Hospital, Chennai during the period of 2014 to 2015 under the guidance of **Prof.Dr.M.K.RAJASEKAR M.S.D.L.O.,** Professor, Institute Of Otorhinolaryngology, Madras Medical College and Rajiv Gandhi General Hospital, Chennai – 3 and submitted to The Tamilnadu Dr. M. G. R. Medical University, Guindy, Chennai – 32 in the partial fulfillment of the regulations for the award of the M.S.E.N.T ., (Branch IV).

Place :Chennai.

Date : **(DR.LOURDES ALBINA.S.A)**

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to **Prof. Dr.VIMALA. M.D,** The Dean, madras medical college, for having permitted me to undertake this study.

First and foremost I like to express my immense gratitude to my guide **Prof.Dr.M.K.RAJASEKAR M.S.D.L.O.,** professor, Upgraded Institute of Otorhinolaryngology, for his valuable guidance, suggestions, encouragement, motivation ,constant supervision ,and help in conducting and fulfillment of this study.

I am immensely grateful to HOD of UIORL **Prof.Dr.R.MUTHUKUMAR, M.S,D.L.O,DNB,** The Director i/c and Professor, Upgraded institute of Otorhinolaryngology, for his valuable support in conducting the study.

I am greatly indebted to **Prof.Dr.G.SANKARANARAYANAN. M.S, D.L.O, DNB.,** Professor , Upgraded Institute of Otorhinolaryngology who helped me in conducting the study.

I express my sincere gratitude to **Prof.Dr.G.SELVARAJAN M.S., D.L.O.,** Professor , Upgraded Institute of Otorhinolaryngology, for his valuable support.

I express my sincere thanks to **THE SECRETARY AND CHAIRMAN, INSTITUTIONAL ETHICAL COMMITTEE,** Government General hospital, Madras Medical College.

I express my sincere thanks to all the assistant professors, for their thoughtful guidance throughout the work.

I thank all my colleagues and friends for their constant encouragement and valuable criticism.

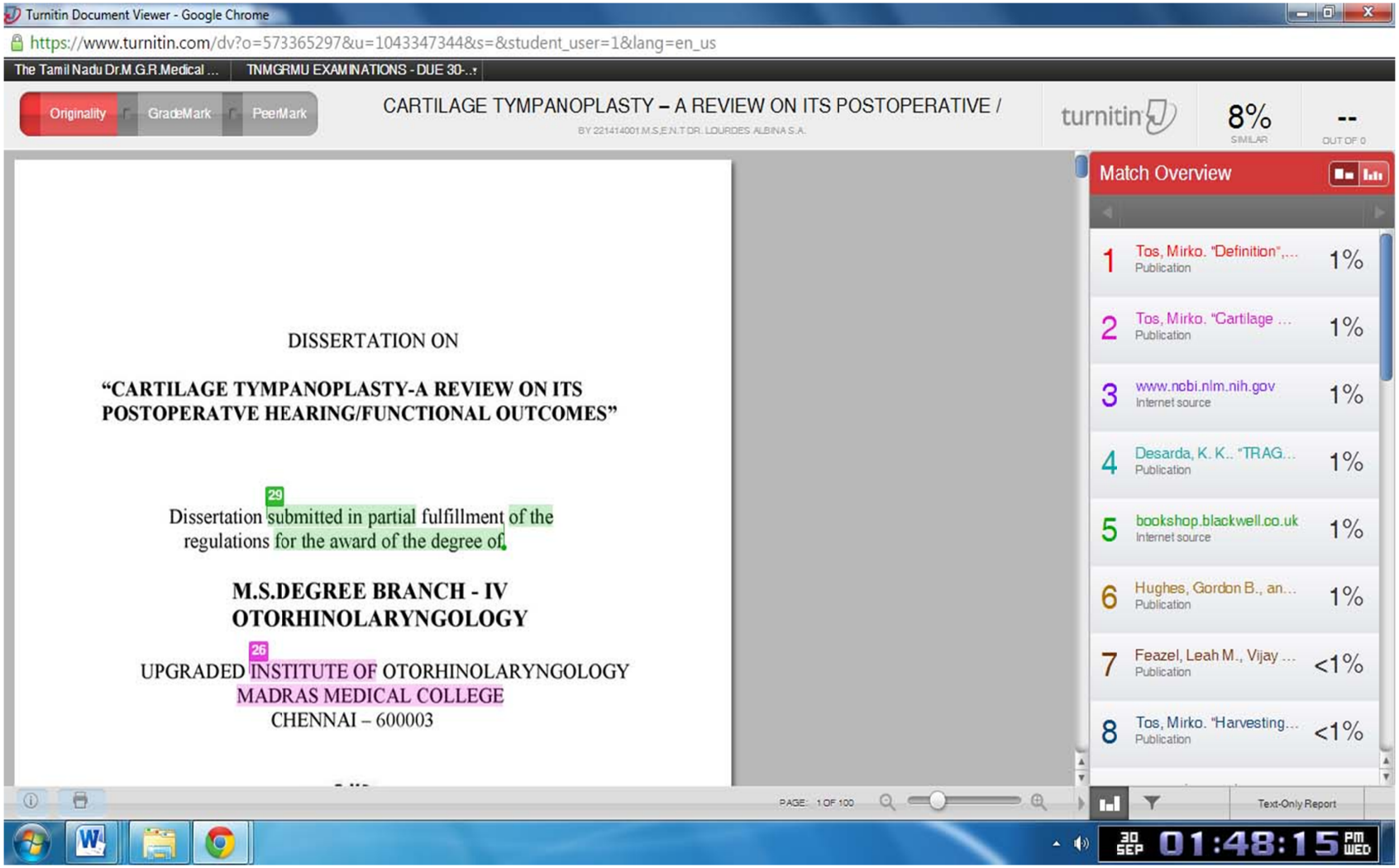
Last but not the least, I express my gratitude for the generosity shown by all the patients who participated in the study.

I am extremely thankful to my parents for their continuous support.

Above all I thank the Almighty God for his immense blessings.

ABRREVIATIONS

SNHL	-	Sensorineural hearing loss
dB	-	Decibel
CT	-	Computerised tomogram
C2	-	Second cervical nerve
C3	-	Third cervical nerve
COM	-	Chronic otitis media
ET	-	Eustachian tube
EAC	-	External Auditory canal
TM	-	Tympanic membrane.
Hz	-	Hertz


Turnitin Document Viewer - Google Chrome
https://www.turnitin.com/dv?o=573365297&u=1043347344&s=&student_user=1&lang=en_us
The Tamil Nadu Dr.M.G.R.Medical ...
TNMGRMU EXAMINATIONS - DUE 30-...
Originality
GradeMark
PeerMark
CARTILAGE TYMPANOPLASTY – A REVIEW ON ITS POSTOPERATIVE /
BY 221414001.M.S,E.N.T DR. LOURDES ALBINA S.A.
turnitin
8%
SIMILAR
--
OUT OF 0
DISSERTATION ON
"CARTILAGE TYMPANOPLASTY-A REVIEW ON ITS POSTOPERATVE HEARING/FUNCTIONAL OUTCOMES"
Dissertation submitted in partial fulfillment of the regulations for the award of the degree of.
M.S.DEGREE BRANCH - IV
OTORHINOLARYNGOLOGY
UPGRADED INSTITUTE OF OTORHINOLARYNGOLOGY
MADRAS MEDICAL COLLEGE
CHENNAI – 600003
Match Overview
1 Tos, Mirko. "Definition",... Publication 1%
2 Tos, Mirko. "Cartilage ... Publication 1%
3 www.ncbi.nlm.nih.gov Internet source 1%
4 Desarda, K. K.. "TRAG... Publication 1%
5 bookshop.blackwell.co.uk Internet source 1%
6 Hughes, Gordon B., an... Publication 1%
7 Feazel, Leah M., Vijay ... Publication <1%
8 Tos, Mirko. "Harvesting... Publication <1%
PAGE: 1 OF 100
Text-Only Report
30 SEP 01:48:15 PM WED

CONTENTS

Introduction

INTRODUCTION

Discharging ear is a cause of significant concern for a person resulting in reduced hearing acuity and also social and psychological consequences. Most of the people with discharging ear will not seek medical attention unless there is greatly reduced hearing loss which impairs their quality of life. Few patients lose life or become crimpled with potentially life threatening complications of COM.

Concerning part of the tympanoplasty is not only to keep the ear dry but also to make the patient to hear as much as possible. Patients with COM, especially the younger group, restrict their interaction with society which may hamper their achievement and advancement in future life. Discharging ear is a double edged sword making the patient lose hearing and also making them prone for complications both intra and extra cranially. Hence, repair of the sound conducting mechanism is of great importance. This can be accomplished well by the use of cartilage grafted either from the tragus or concha, though temporalis fascia is commonly used. In this study we can analyse the functional outcomes on hearing after cartilage tympanoplasty.

Aim of the study

AIM OF THE STUDY

The aims of the study were as follows

1) To compare pre and post operative hearing.

2) To prevent lateralisation and blunting of the graft.

Materials and Methods

MATERIALS & METHODS

PLACE OF STUDY:

Rajiv Gandhi Govt. General Hospital, Chennai – 600003.

COLLABORATING DEPARTMENT:

Upgraded Institute of Otorhinolaryngology

STUDY DESIGN **:** Prospective and retrospective Study

STUDY PERIOD **:** July 2014 to September 2015

SAMPLE SIZE **:** 35

DATA COLLECTION **:** Patients attending UIORL

INCLUSION CRITERIA :

1. Type of disease (Tubotympanic / Attico antral)
2. Age > 12 years, <60 years

EXCLUSION CRITERIA:

1. COM with impending / overt complications.
2. COM with severe SNHL
3. Age <12years, >60years

INVESTIGATIONS:

- Pure tone audiogram pre and post-operative
- Impedance audiometry
- Otoendoscopy
- X-ray both mastoids – laws view
- CT – Nose & PNS in B/L CSOM

BENEFIT TO THE COMMUNITY :

To demonstrate the efficacy of cartilage tympanoplasty.

CONFLICT OF INTEREST : - Nil -

FINANCIAL SUPPORT : - Nil –

ETHICAL COMMITTEE APPROVAL

Institutional ethical committee, Government General Hospital , Madras Medical College, Chennai reviewed the experimental design and protocol as well as the letter of information and consent form. Full approval of the board was granted. All patients were given information outlining the experimental protocol and all patients signed a consent form prior to entering the study.

METHODOLOGY

This study design is both retrospective and prospective study conducted in Upgraded Institute of Otorhinolaryngology, Government General Hospital, Chennai from July 2014 to August 2015. Those patients with absence of ear discharge for a minimum of 6 weeks and evidence of small to medium sized central perforation on otoscopy. All patients undergo cartilage tympanoplasty with ossicular reconstruction in case of diseased ossicles. Their post operative outcomes are compared with preoperative audiogram.

From September 2014 to August 2015, cartilage tympanoplasty was performed using tragal cartilage in 35 patients. (Out of which, 19 were male and 16were female, age ranging from 12-60 years).

Of all the cases selected for the study to do cartilage tympanoplasty, all were primary procedures except for one case. Of the procedures done, 2 cases were with postero-superior retraction pockets,2 cases were with attic cholesteatoma. Out of patients with mucosal disease, 27 cases were inactive and 1 was active for which we did cortical mastoidectomy with cartilage tympanoplasty. Of the cases studied, 24 had bilateral ear disease and 11 had unilateral ear disease.

Type 1 tympanoplasty was performed for 31 patients, type 3 for one patient,type 1 with ossiculoplasty was performed for 1,revision intact canal wall with type 3 tympanoplasty was done for 1. All the cases were done in single centre, Upgraded Institute of Otorhinolaryngology, Chennai. The procedure was not done by a single surgeon. The following parameters were studied: graft take up, change between pre and post op pure tone audiogram showing improvement in air bone gap, progression/regression of retraction.

If there is no perforation, retraction or lateralisation , it is labelled as successful graft uptake. The PTA-ABG for each audiogram was made out by calculating the mean air bone gap at 500, 1000, 2000and 4000Hz. Pre and post operative audiograms were compared using ‘t’ test.

Institutional ethical committee clearance and patient consent was obtained for the study.

Review of Literature

REVIEW OF LITERATURE

HISTORY

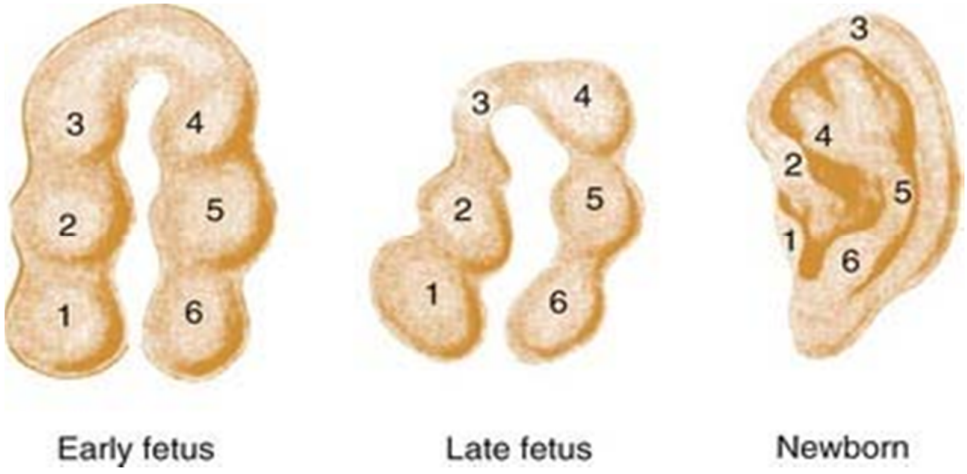
- The attempts to repair the tympanic membrane perforation was made from seventeenth to nineteenth century.
- The use of paper patch for tympanic membrane was developed by Blake in 1887.
- The application of chemical cauterising agents for the promotion of tympanic membrane perforation healing was first introduced by Roosa in 1876 with the use of silver nitrate.
- Use of trichloroacetic acid was advocated first in 1895.
- Joynt made a technique combining the use of cautery and paper patch method following which closure of tympanic membrane improved. This formed the paper patch technique basis which was made popular by Derlacki.
- In 1952, split thickness graft was used by Wullstein for repair of the tympanic membrane and published the results. Zollner described his experiences with a similar graft.
- In 1956, Zollner used fascia lata from thigh to close the peforation.

- In 1958, Heermann started using the temporalis fascia.
- 1960, Shea used vein graft for the repair of the tympanic membrane perforation.
- First series of the cartilage myringoplasty techniques was published by Sale.

EMBRYOLOGY

PINNA

"The development of the pinna starts at the fourth week of intra uterine life as tissue condensations of the mandibular and hyoid arches appear at the distal part of the first branchial groove. Six ridges, known as the hillocks of His, arise from the tissue condensations within two weeks. From the second branchial arch(hyoid arch),all parts of the pinna except the tragus and anterior portion of the external auditory canal(develops from the first mandibular arch)develops. Independent of the development of the middle and inner ear, adult configuration of the pinna is achieved by fifth month".



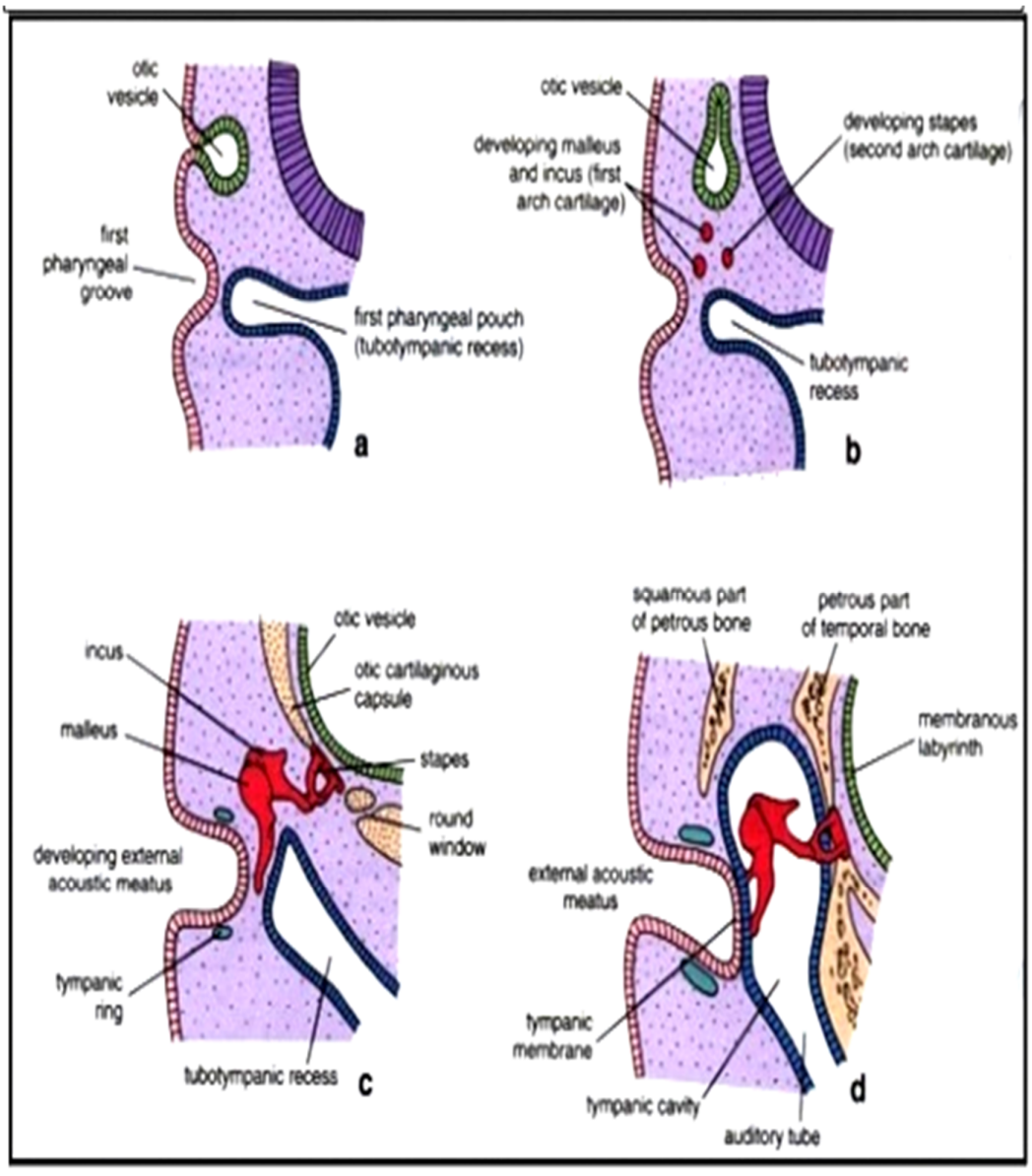
Development of pinna from six hillocks of His derived from the first and second branchial arches.

EXTERNAL AUDITORY CANAL

"During the second month, the dorsal part of the first brachial groove deepens which gives rise to external auditory canal progressively. The endoderm of the tubo-tympanic recess is abutted by the ectoderm of the first brachial groove. In the sixth week in-growth of the mesoderm this breaks the above stated contact. The primary external auditory canal is formed by the deepening of the inferior portion of the first brachial groove corresponding to the fibrocartilaginous portion of the adult size. Marked by the appearance of the membranous ossification centre, the squamous portion of the temporal bone development starts at the same time. A solid cord of epithelial cells grows at the depth of the developing external auditor canal thus terminating into solid (meatal plate) medially. The lamina propria of the tympanic membrane id formed by the adjacent mesenchyme of the tympanic ring and is surrounded by the four membranous ossification centres of the tympanic ring. Except superiorly the tympanic ring fuses superiorly described as notch of Rivinus. By the solid growth of the cells, elements of the tympanic ring expansion occurs. Initially the cord splits open at the medial terminus by the fifth month and by seventh month the formation of the bony canal occurs. The epithelial lining of the cells at the periphery forms the epithelial lining of the canal and the superficial layer of the tympanic membrane is formed by the cells which is remaining medially. The first brachial pouch lining epithelium derives the medial tympanic membrane layer.

The deepening of the first branchial groove and expansion of tubo-tympanic recess giving rise to primitive external auditory canal and middle ear cavity".

EAR - EMBRYOLOGY



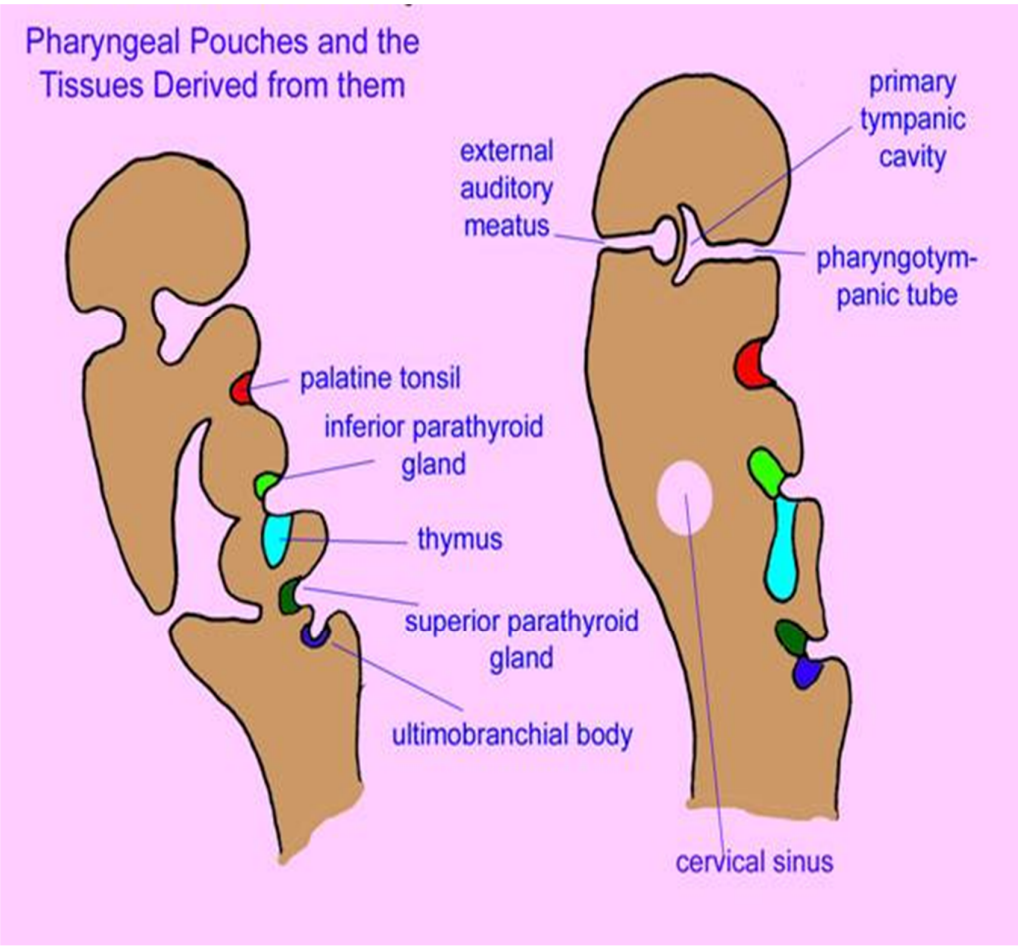
MIDDLE EAR

"The cavity and lining of the middle ear cleft and Eustachian tube arises from the first expanding pharyngeal pouch with probably some contribution from the medial edge of second pharyngeal pouch. By the fourth week of intrauterine life, the distal end lying against the 1st pharyngeal ectoderm of the groove and expands to form the flattened sac- the precursor of the tympanic cavity".

"Mesenchyme grows between the ectoderm and endoderm to form the third layer of the future developing tympanic membrane. A expanding slit like space within the sac, reaches the developing ossicles and otic capsule the epithelium lining the sac is draped over the tympanic portion of the labyrinths.

The bodies of developing ossicles and along with their ligaments and muscular tendons forms a complex and variable networks of mucosal folds. Pneumatisation of the mesotympanum and hypotympanum is complete by 8th month of intra uterine life, while the epitympanum and mastoid antrum will be developing by birth. The mastoid antrum which is an extension of the epitympanum has started to develop in middle of the fetal life. Few mastoid air cells are present in fetal life, but the entire bulk of their development takes place during infancy and childhood".

DEVELOPMENT OF EAR FROM PHARYNGEAL ARCHES



This picture shows external auditory canal is developed from the dorsal end of first pharyngeal arch and middle ear cavity from the pharyngotympanic tube.

Development of Ossicles :

"The outer lateral ends of the first (Meckel's) and second (Reicherts) arch cartilage lie above and below the developing first pharyngeal pouch respectively. Before these arch cartilages are defined fully, the condensations in the mesenchyme appear in this region at about fifth week. As the development proceeds, the condensations from models of cartilage by sixth week are well defined as malleus, incus, stapes. By fourth week, the stapes can be recognized as a circular mass at the end of the Reicherts (second arch) cartilage precursor.

Around 2 weeks later, this becomes annular as it is pierced by (first arch stapedial artery) and is now attached to the developing Reicherts cartilage by a membranous bar. At this time, malleus and incus are developing from cartilage at the end of precursor of Meckels cartilage.

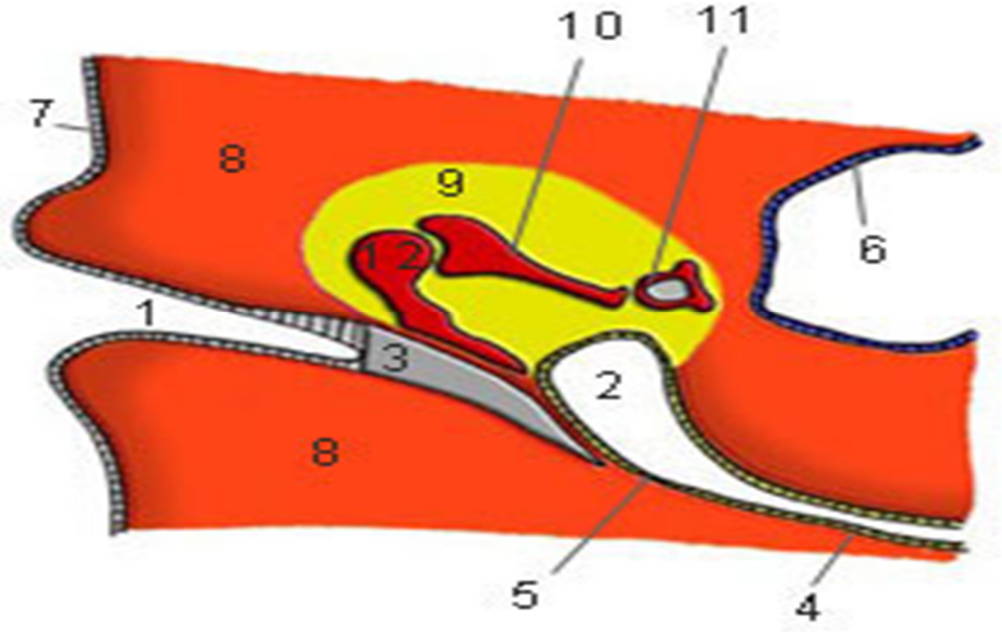
The site of the future incudomalleolar joint and the handle of malleus and long process of incus are already apparent by a developing groove. By seventh week, the handle of malleus lies in between the layers of the developing tympanic membrane.

The stapes grows continuously and its ring like shape is converted into a definitive arch like stapedial form. It seems likely that foot plate

of the stapes in formed primarly from the otic capsule, and that part of the stapedial ring which fuses with the otic capsule during ossifications usually regresses later.

Therefore, in the adult the stapedial arches are developed from second arch cartilage while the foot plate is a part of the labrynthine capsule. Regression of the base of the stapedial ring is incomplete so that dual origin for the mature foot plate is possible frequently. From a single centre the ossification of the stapedial cartilage develops by 4-5 months and is followed by a complex pattern of resorption resulting eventually hollowing of the crura and the adjoining head. By the 4 month of intrauterine life, the malleus and incus start ossifying and progresses so rapidly that by the 25^{th} week of fetal life they are attain the size and forms of an adult".

EMBRYOLOGY OF EAR



This picture shows developing external and middle ear cavity.

1. External auditory meatus
2. Primitive tympanic cavity
3. Meatal plug
4. Auditory tube
5. Endoderm
6. Wall of inner ear
7. Surface ectoderm
8. Loose mesenchyme
9. Incus
10. Stapes
11. Malleus

ANATOMY

"The contour of pinna is determined by the configuration of the frame of its elastic cartilage. Its lateral surface of the pinna is dominated by concavities, the concha, in particular. Skin of the lateral and medial surfaces of the pinna possesses hair and both sebaceous and sudoriferous glands; The attachment of the skin is however different, tightly bound to the perichondrium laterally and on the medial aspect it is only loosely attached. To the tympanic bone the pinna is securely attached by the its cartilage continuity and with that of cartilaginous external auditory canal (EAC). The pinna is loosely attached to the skull by its connective tissue, skin, three extrinsic and six intrinsic muscles and ligaments. Innervation of the intrinsic muscles is by the posterior auricular nerve, a branch of the facial nerve, which in general poorly developed in the human".

The cartilaginous frame work of the pinna showing triangular fossa, scaphoid fossa, concha clearly.

EXTERNAL AUDITORY CANAL

"The lateral one-third of the EAC comprises a continuation of the cartilage of the pinna and is deficient superiorly at the incisura terminalis. The two or three variably present perforations in the anterior aspect of the cartilaginous canal are the fissures of Santorini. The remaining medial two-thirds of the approximately 2.5-cm length of the canal are bony. The isthmus, the narrowest portion of the EAC, lies just medial to the junction of the bony and cartilaginous canals.

The skin of the cartilaginous canal has a substantial subcutaneous layer, replete with hair follicles, sebaceous glands, and cerumen glands. The skin of the osseous canal, in contrast, is very thin and its subcutaneous layer is bereft of the usual adnexal structures. Accordingly, the absence of hair serves to distinguish the bony and cartilaginous canals".

Innervation

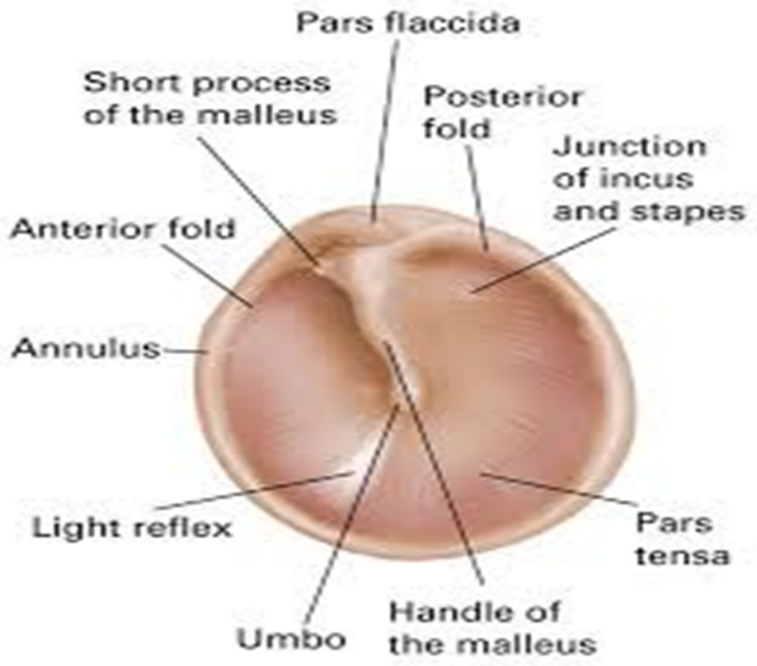
Sensory innvervation of ear is contributed by various branches as follows

- The auriculotemporal branch of the trigeminal nerve,
- greater auricular nerve (a branch of C3),
- lesser occipital nerve (of C2 and C3 derivation),

- auricular branch of the vagus nerve (Arnold's nerve), and
- twigs from the facial nerve
- ***Tympanic Membrane***

"The tympanic membrane emulates an irregular cone, the apex of which is formed by the umbo (at the tip of diameter and subtends an acute angle with respect to the inferior wall of the EAC. The fibrous annulus of the tympanic membrane anchors it in the tympanic sulcus. In addition, the tympanic membrane firmly attaches to the malleus at the lateral process and at the umbo; between these two points, only a flimsy mucosal fold, the plica mallearis, connects the tympanic membrane to the malleus. The tympanic membrane is separated into a superior pars flaccida (Shrapnell's membrane) and a pars inferior by the anterior and posterior tympanic stria, which run from the lateral process of the malleus to the anterior and posterior tympanic spines, respectively. Shrapnell's membrane serves as the lateral wall of Prussak's space (the superior recess of the tympanic membrane); the head and neck of the malleus, the lateral malleal ligament, and anterior and posterior malleal folds form the medial, anterosuperior, and inferior limits of Prussak's space. The tympanic membrane is a trilaminar structure. The lateral surface is formed by squamous epithelium, whereas the medial layer is a continuation of the mucosal epithelium of the middle ear. Between these layers is a fibrous

layer, known as the parspropria. The pars propria at the umbo splits to envelop the distal tip of the manubrium".

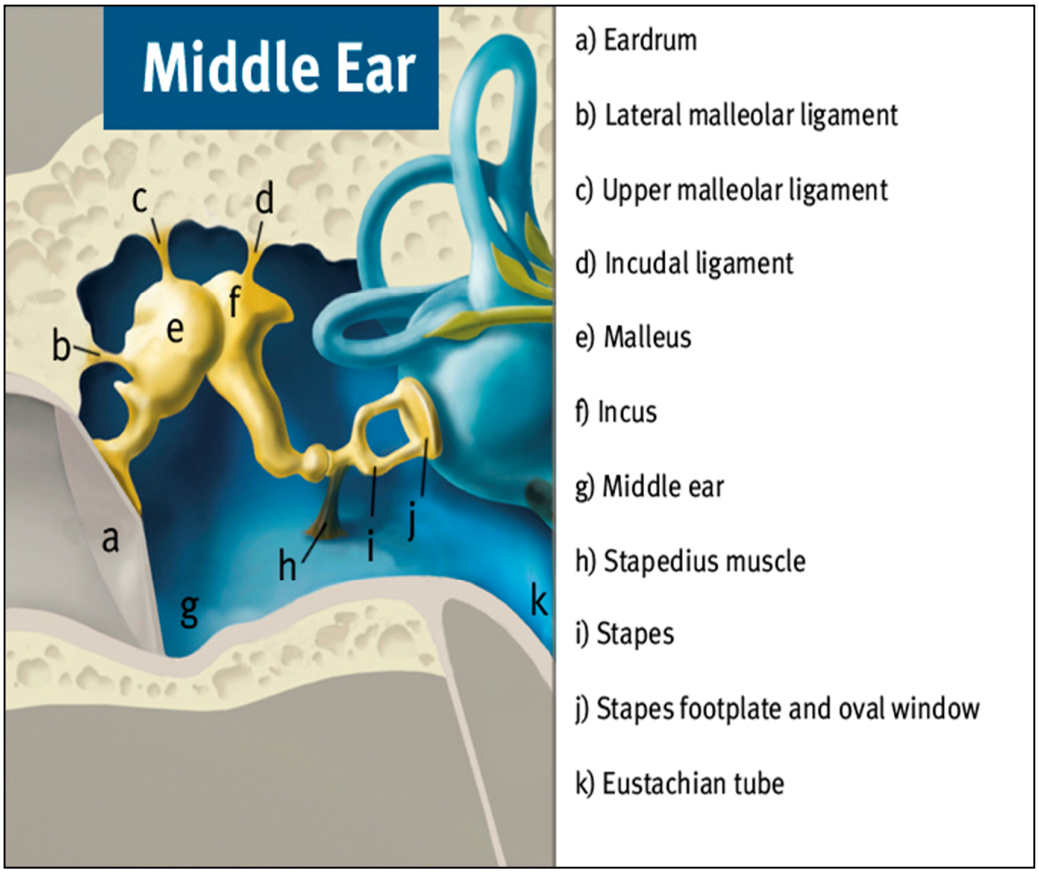


The right tympanic membrane clearly showing pars flaccida, pars tensa and various anatomical landmarks.

The tympanic cavity

"The tympanic cavity is divided functionally into three compartments: the upper epitympanum the middle mesotympanum and the lower hypotympanum. The attic or epitympanum , lies above level of the malleolar folds and is separated from mesotympanum and hypotympanum by a series of mucosal folds and membranes. The

hypotympanum lying below the level of the inferior part of the tympanic sulcus is continuous with mesotympanum above".



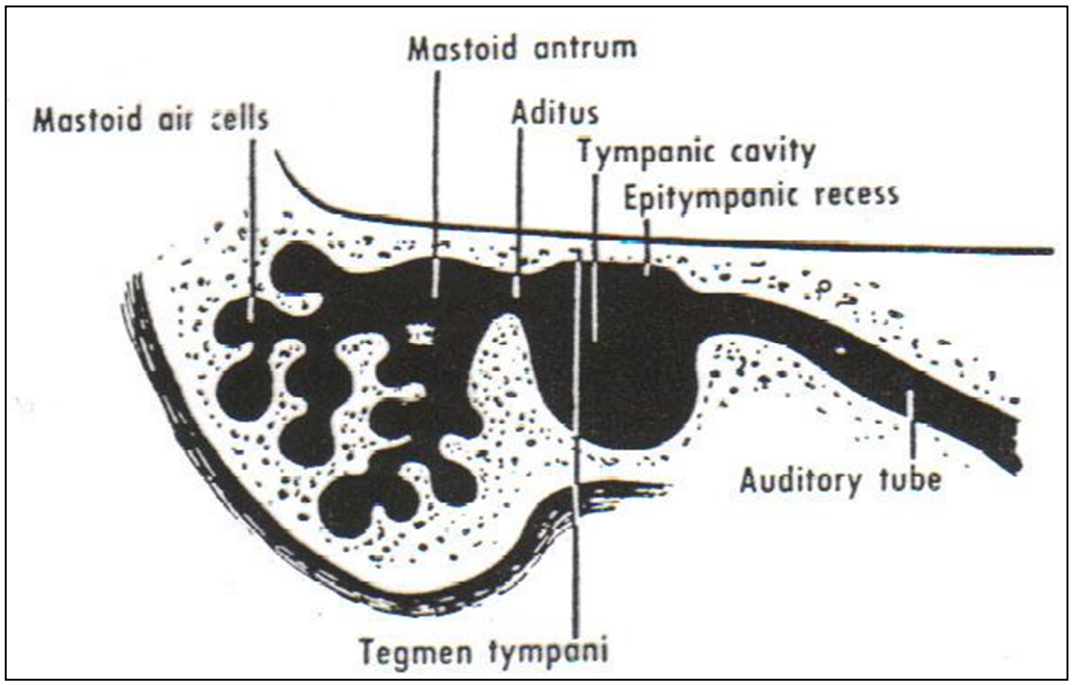
THE LATERAL WALL

"The lateral wall is formed superiorly by the lateral bony wall of the epitympanum, centrally the tympanic membrane and inferiorly the bony lateral wall of the hypotympanum. The lateral epitympanic wall is wedge-shaped and inferior sharp portion is called the outer attic wall or scutum (Latin meaning: shield). There are three holes are present in the

medial surface of the bony lateral wall of the tympanic cavity. A slit which is about 2 mm long opens anteriorly just above the attachment of the tympanic membrane is the petrotympanic fissure, receiving the anterior malleolar ligament and transmitting a branch of the anterior tympanic branch of the maxillary artery to the tympanic cavity . The chorda tympani carries taste sensation from the anterior two-thirds of the ipsilateral side of the tongue and to the submandibular gland secretomotor fibres, enters the medial surface of the fissure through a separate canaliculus, anteroior canliculus(canal of Huguier) which is confluent sometimes with the fissure. It runs posteriorly then between the fibrous and the mucosal layers of the tympanic membrane, across the upper part of the malleus handle and continues then within the membrane, but below level of the posterior malleolar fold. The nerve reaches posterior bony canal wall just medial to the tympanic sulcus, enters the posterior canaliculus and then obliquely runs downwards and medially through the posterior wall of the tympanic cavity until it reaches the seventh cranial nerve, facial nerve. Quite variable is the point of entry of the chorda tympani into the bundle of the facial nerve. This is at the level of the inferior third of the facial canal on its anterior wall usually, but on occasions by a separate foramen chorda tympani nerve can leave the skull base before joining the facial nerve".

THE ROOF

"The epitympanum roof is the tegmen tympani, which is a thin bony plate separating the middle ear space from the middle cranial fossa. Both the petrous portion and squamous portion of the temporal bone form the tegmen tympani; and the petrosquamous suture line, can provide a route of access for infection into the extradural space in children if it is not closed until adult life. From the tympanic cavity veins running to the superior petrosal sinus pass through this petrosquamous suture line" .



The communication of the mastoid air cells and tympanic cavity via the aditus.

THE FLOOR

"The floor of the tympanic cavity may consist of pneumatised or compact bone that separates the hypotympanum from the dome of the jugular bulb.

According to the height of the jugular fossa, its thickness can vary. The floor may be deficient and the jugular bulb is covered only occasionally then by a mucous membrane or a fibrous tissue. At the junction of the floor and medial wall of the cavity, a small opening is present allowing the entry of the tympanic branch of the glossopharyngeal nerve from its origin below the skull base into the middle ear".

THE ANTERIOR WALL

"Rather narrower is the anterior wall of the tympanic cavity is as the lateral and medial walls converges. The anterior wall in its lower-third of consists of a thin plate of bone covering the carotid artery during its entry into the skull and before turning anteriorly. The superior and inferior carotico-tympanic nerves carrying sympathetic fibres to the tympanic plexus, and the tympanic branches of the internal carotid artery perforates this plate. The tympanic orifice of the Eustachian tube comprises the middle-third, is oval 5 x 2 mm in size. A canal containing

the tensor tympani muscle is enclosed in a thin bony sheath is just above subsequently running along the medial wall of the tympanic cavity. The upper-third is pneumatized usually and may house anterior epitympanic sinus, represented by a small niche anterior to the ossicular heads, which can be a site for hidden residual cholesteatoma in canal wall up surgery".

THE MEDIAL WALL

"The internal ear is separated from the tympanic cavity by the medial wall.

A rounded elevation is the promontory which occupies much of the medial wall in its central portion, covering the part of the basal coil of the cochlea and on its surface has usually small grooves containing the nerves forming the tympanic plexus. The groove sometimes may be covered by bone containing tympanic branch of glossopharyngeal nerve, forming a small canal. Gently inclining forwards the promontory merges with the anterior wall of the tympanic cavity and posteriorly is more steeply sloped. The oval window is above and behind the promontory and is nearly a kidney-shaped opening which connects the tympanic cavity and the vestibule, which later in life is closed by the stapes footplate and the surrounding annular ligament. Its size varies naturally with the footplate size, on average it is 1.75 mm wide long and 3.25 mm

deep. Depending on the position of the facial nerve at the bottom of a depression or niche lies the oval window which can vary in its width superiorly, and the prominence of the promontory inferiorly. Below and a little behind the oval window niche is the round window niche separated by a subiculum, posterior extension of the promontory. Above the subiculum is the another ridge of bone – ponticulus - leaving the promontory occasionally, and running to the pyramid on the posterior wall of the tympanic cavity. Most commonly the round window niche is triangular in shape. Between the ponticulus and subiculum in the postero-inferior wall, the sinus tympani lies medial to the facial nerve. The ponticulus and sinus tympani meet posteriorly leading to the sinus tympani. The round window membrane is oval in shape roughly, lies in a plane at right angles to the plane of the footplate of stapes and is about 2.3x 1.9 mm in dimension. It has a tendency to curve towards the the cochlea the basal coil - scala tympani so that when viewed from the middle ear it is concave, and thus appears to be divided by a transverse thickening into an anterior and posterior portion".

"Above the promontory and oval window runs the Fallopian (facial nerve canal) canal in an antero-posterior direction. It often has microdehiscences, which is smooth and rounded lateral surface, there are two or three straight blood vessels running along are clearly visible when

the nerve is exposed by the disease or the bone is thin along this line of nerve. In the middle ear, these are the only straight blood vessels and indicating quite clearly that facial nerve is very close by. The Fallopian canal is marked anteriorly by the processus cochleariformis, a curved bony projection, which is concave anteriorly, housing the tendon of the tensor tympani muscle as it turns laterally to the malleus handle. Behind the oval window, the facial canal starts to turn inferiorly, beginning its descent in the posterior wall of the tympanic cavity. The medial wall of the epitympanum is formed by the region above the level of the facial nerve canal. The major feature of the posterior portion of the epitympanum, is the dome of the lateral semicircular canal which is lying posterior extending a little lateral to the facial canal".

"The labyrinthine bone over superior semicircular canal may be prominent, in well aerated mastoid bones, running at right angles to the lateral canal joining it anteriorly at a swelling which houses the ampullae of the two semicircular canal. A slight swelling corresponding to the geniculate ganglion, lies above the processus cochleariformis within the bony canal of the greater superficial petrosal nerve running for a short distance anteriorly in front and a little below it".

THE POSTERIOR WALL

"The posterior wall has a large irregular opening in its upper part - the aditus and antrum is wider above than below, that leads to the posterior epitympanum into the mastoid antrum from the back . The fossa incudis is a small depression below the aditus, housing the incus short process and its suspensory ligament. The pyramid is below the fossa incudis and is medial to the opening of the chorda tympani nerve, a small hollow conical projection anteriorly with its apex pointing housing the stapedial muscle and tendon, which inserts into the head of stapes in its posterior aspect pyramid Curving downwards and backwards the canal within it joins of the facial nerve canal in the descending portion. Between the pyramid and facial nerve, and the annulus of the tympanic membrane lies the groove, the facial recess. It is shallower lower down where the Fallopian canal on the posterior wall of the tympanic cavity forms only a slight prominence. Boundaries of the facial recess therefore, by the facial nerve medially, by the tympanic annulus laterally, between the two obliquely with the chorda tympani nerve running through the wall .Medial to the tympanic membrane, the chorda tympani always runs allowing a posterior tympanotomy which means that the angulation between the facial nerve and the chorda tympani nerve, thereby accessing the middle ear from the mastoid without disruption to the tympanic

membrane. Depending on the site of origin of chorda tympani from the facial nerve, this angle can be small or large. A posterior extension of the meso tympanum is the sinus tympani and lies deep to both the facial nerve the promontory. There can be extensive extension of air cells into the posterior wall, and probably in the middle ear and mastoid the most inaccessible site. When measured from the tip of the pyramid, as far as 9 mm the sinus can extend into the mastoid bone. The sinus tympani in its medial wall becomes continuous with the medial wall of the tympanic cavity in its posterior portion where it is related to the round and oval window niches and the subiculum . It can communicate with the mastoid air cells on rare occasions".

Ossicles

"Malleus, incus, and stapes, constitutes the ossicular chain and serves to conduct the sound from the tympanic membrane to the cochlea. The most lateral of the ossicles, is the malleus and has a head (caput), manubrium (handle), neck, and lateral and anterior processes. A cartilaginous cap is in the lateral process and merges imperceptibly with the tympanic membrane the pars propria. Through the petrotympanic fissure the anterior ligament of the malleus, extends from the anterior process, passes and, with the posterior incudal ligament, creates an axis of ossicular rotation. The largest of the three ossicles, the incus,is medial to

the malleus immediately . The incus has three processes: a long, a short, and a lenticular and a body. In the epitympanum the head of the malleus articulates with the body of the incus. By the posterior incudal ligament, the short process of the incus is anchored to the incudal fossa. Inferiorly extends the long process paralleling roughly and lying posterior to the manubrium of the malleus. At the terminus of the long process, the lenticular process, articulates with the stapes. The smallest among the ossicles is the stapes and is most medial of the three ossicles. The stapes head articulates with the incus in its lenticular process, surrounded by the stapediovestibular ligament, its footplate sits in oval window. The stapes arch, is composed of an anterior crus and a posterior crus, which links the head and the footplate. Perhaps owing to its tenuous blood supply, the long process of the incus is prone particularly to osteitic resorption in the phase of chronic otitis media".

"The force of injudicious surgical manipulation can overcome easily the restraints, by which the ossicles are held in position namely by the ligaments and tendons, resulting in complete luxation or subluxation. One should be parallel to the plane of the tendon of then stapedius, when dissecting disease from the stapes, in a posterior to an anterior direction, so that the stapedial tendon resists the displacement of the stapes".

Middle Ear Muscles

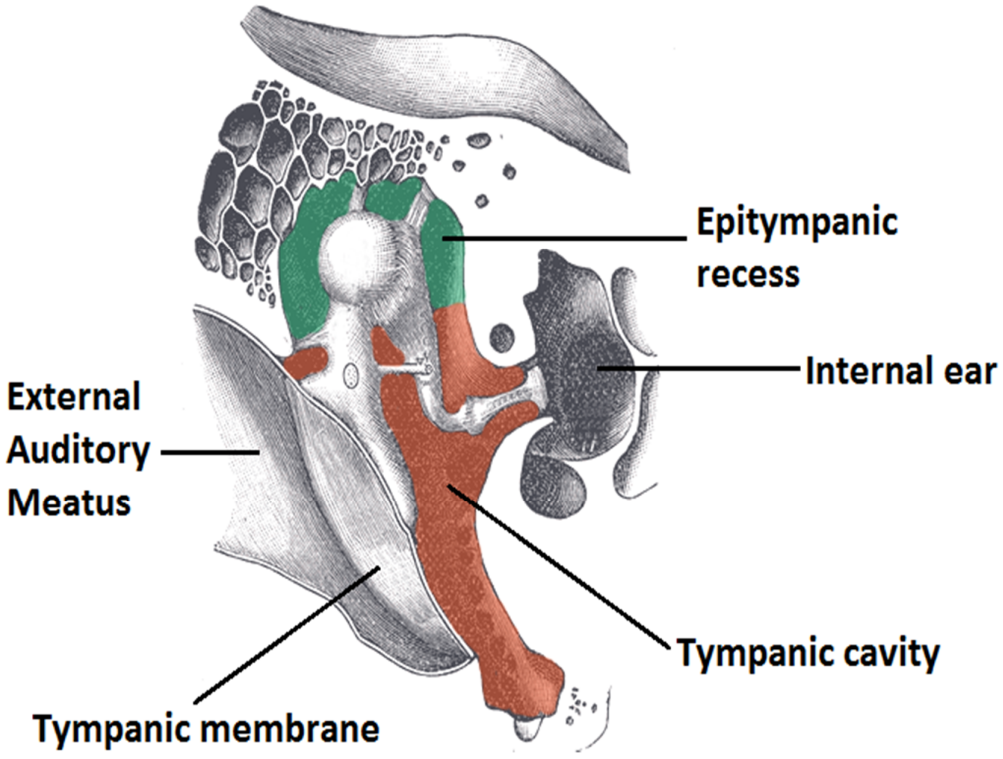
"The tensor tympani muscle, originates from the walls of its semicanal, greater wing of the sphenoid, and cartilaginous portion of the Eustachian tube and is innervated by the branch of mandibular nerve, trigeminal nerve."

"The tendon of tensor tympani sweeps around the cochleariform process and across the tympanic cavity gets attached to the medial aspect of the neck and manubrium of the malleus. The medial pull of this muscle is ordinarily opposed by the intact tympanic membrane. In case of a chronic, substantial perforation of the tympanic membrane, the manubrium is medialized by the unopposed action of the tensor tympani, contracting effectively the tympanic cavity depth. Sectioning of the tensor tympani tendon or forcible lateralization of the malleus, may be required by the surgeon thus allowing to perform ossiculoplasty or tympanic membrane grafting. The landmark to the anterior aspect of the facial nerve tympanic segment is the cochleariform process, as the nerve runs immediately superior to this process. In the posterior wall of the tympanic cavity, the stapedius muscle runs in a vertical sulcus adjacent to the course of the facial nerve, from which the stapedius receives its nerve supply. Traversing the pyramidal eminence its tendon gets attached to the posterior crus, and the head of the stapes occasionally. The tympanic

cavity is divided into a protympanum, mesotympanum, hypotympanum, and posterior tympanic cavity. Above the plane of the anterior and posterior tympanic spines, lies the epitympanum .The mesotympanum is dominated anteriorly, by the bulge of the semicanal of the muscle of the tensor tympani; immediately inferior to this bulge is the tympanic orifice of the eustachian tube. The key anatomic features posteriorly, are the pyramidal eminence and, the chordal eminence lies lateral to it. The chorda tympani nerve enters the tympanic cavity via the chordal eminence which houses the iter chordae posterius. The surgical floor of the middle ear, the medial wall features three depressions: the sinus tympani, oval window niche, and round window niche. The sinus tympani is defined by the subiculum inferiorly, the ponticulus superiorly, the posterior semicircular canal medially and the mastoid segment of the facial nerve laterally; ranging from “shallow” to “deep” there is substantial variability in the sinus tympani posterior extension . The oval window niche, is located anterosuperior to the ponticulus and is occupied by the footplate of stapes. Postero-inferior to the promontory, the round window niche can be found”.

Middle Ear Spaces

"Lying immediately medial to the tympanic membrane is a sagittally oriented slit, the tympanic cavity. The tegmen or its roof serves as a part of the floor of the middle cranial fossa, jugular bulb is featured by the it's irregularly contoured floor and posteriorly is the root of the styloid process. Anteriorly the tympanic cavity is in continuity with the pharyngo tympanic tube and with the mastoid air cells via the aditus and antrum. It is lined with a mucosal epithelium is traversed by the ossicular chain .Planes extended from the tympanic annulus subdivide the tympanic cavity into a mesotympanum, hypotympanum, protympanum, and posterior tympanic cavity".



“The epitympanum lies above the plane of the anterior and posterior tympanic spines. Anteriorly, the mesotympanum is dominated by the bulge of the semicanal of the tensor tympani muscle; the tympanic orifice of the Eustachian tube is immediately inferior to this bulge . Posteriorly, the key anatomic features are the pyramidal eminence and, lateral to it, the chordal eminence. The chordal eminence houses the iter chordae posterius by which the chorda tympani nerve enters the tympanic cavity. The medial wall features three depressions: the sinus tympani, oval window niche, and round window niche”.

“The sinus tympani is defined by the inferiorly subiculum, superiorly ponticulus, medially the posterior semicircular canal and laterally the the mastoid segment of the facial nerve. The oval window niche, occupied by the stapes footplate, is located anterosuperior to the ponticulus. Posteroinferior to the promontory, the bulge created by the basal turn of the cochlea the round window niche can be found.

Through the arch of the superior semicircular canal the subarcuate tract passes. Superior and inferior to the bony labyrinth, runs the perilabyrinthine tracts .The Eustachian tube is surrounded by the peritubal tract. Running parallel and inferior to the posterosuperior tract is the posteromedial tract”.

THE STAPEDIUS MUSCLE

"From the walls of the conical cavity within the pyramid the stapedius arises and in front of descending portion of the facial nerve from the downward curved continuation of this canal. This slender tendon emerging from the apex of the pyramid and gets inserted into the stapes. A small branch of the facial nerve supplies the stapedius muscle by a muscular branch".

THE TENSOR TYMPANI MUSCLE

"Arising from the walls of the bony canal is a long slender muscle, tensor tympani lies above the Eustachian tube. It also arises from the Eustachian tube cartilaginous portion and the greater wing of the sphenoid. From its point of origin, the muscle passes backwards into the tympanic cavity lying on the medial wall of the middle ear, a little below the level of the facial nerve. The muscle is replaced by a slender tendon bony covering canal where in its tympanic segment is deficient. On entering the processus cochleariformis tensor tympani by a transverse tendon is held down through a right angle as it turns and passes laterally to get inserted into the medial aspect to the handle of the malleus in its upper end. By the way of a branch from the medial pterygoid nerve, the

muscle is supplied from the mandibular nerve, a branch of trigeminal nerve".

.

THE CHORDA TYMPANI NERVE

"From the posterior canaliculus, the chorda tympani branch of the facial nerve enters the tympanic cavity at the junction of the posterior and lateral walls. It runs across tympanic membrane the medial surface, between the fibrous and mucosal layers and passing medial to upper portion of the handle of the malleus above the tensor tympani tendon to continue forwards and to leave by the way of the anterior canaliculus, that subsequently joins the petrotympanic fissure".

THE TYMPANIC PLEXUS

"The tympanic plexus is formed by caroticotympanic nerves which arise from the sympathetic plexus around the internal carotid artery and by the tympanic branch (Jacobson's nerve) of the glossopharyngeal nerve. On the promontory, these nerves form a plexus providing branches to the tympanic cavity, Eustachian tube and mastoid antrum and air cells mucous membrane lining. The tympanic plexus also provides branches joining greater superficial petrosal nerve and lesser superficial petrosal nerve which contains all the parasympathetic fibres of the ninth cranial nerve, glossopharyngeal nerve".

THE MUCOSA OF THE TYMPANIC CAVITY

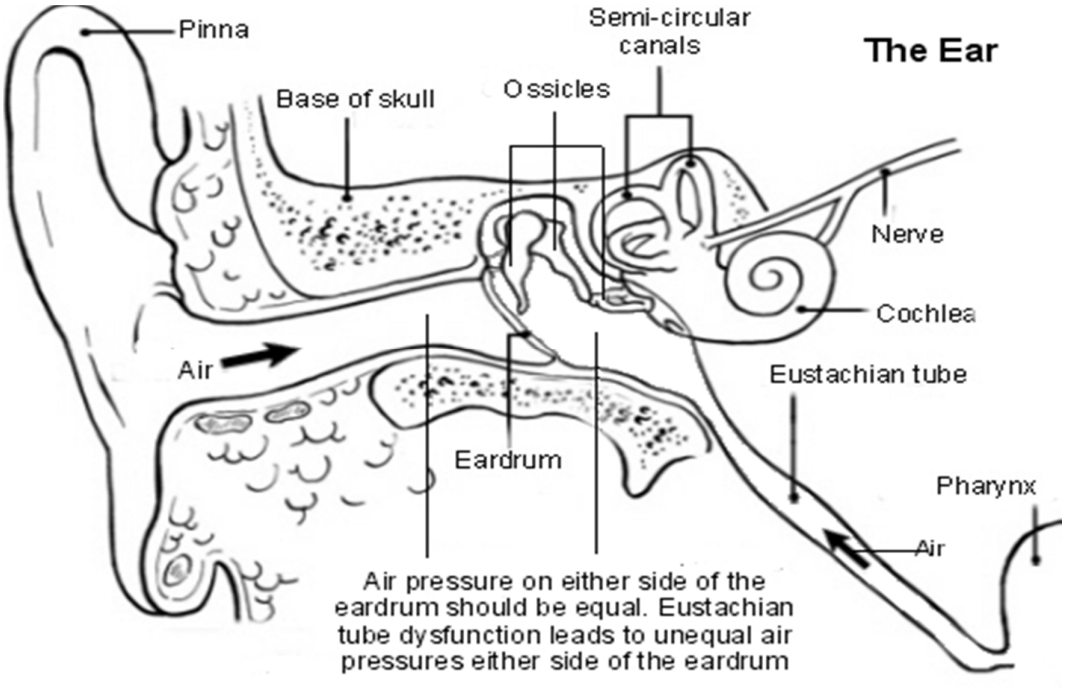
"The mucosa of the middle ear is essentially respiratory mucosa mucus-secreting bearing cilia on its surface. In normal middle ears, extent of the mucociliary epithelium is variable and is being more widespread in the young.Three distinct mucociliary pathways identified - hypotympanic, promontorial and epitympanic, the former being the largest. All these pathways coalesces at the Eustachian tube tympanic orifice. Bony walls of the tympanic cavity and ossicles and their supporting ligaments are covered by the mucous membrane forming the mucosal folds".

"The tendons of the two middle ear muscles namely tensor tympani and stapedius are also covered by mucosal folds and they carry blood supply to and from the tympanic cavity contents. The mucosal folds separates the middle ear space into compartments resulting, the only ventilation route of the epitympanic space from the mesotympanum is through two small openings between various mucosal folds -the anterior and posterior isthmus tympani. Prussak's space is found between the neck of the malleus and the parsflaccida, bounded by the lateral malleolar fold".

THE BLOOD SUPPLY OF THE TYMPANIC CAVITY

"The walls and contents of the tympanic cavity are supplied by the branches arising from both the external and internal carotid system. There is an extensive overlap between branches and great variability in the blood supply between individuals".

The Eustachian tube



"The Eustachian tube is a dynamic channel that connects the middle ear with the nasopharynx. It is about 36mm in length, in adults

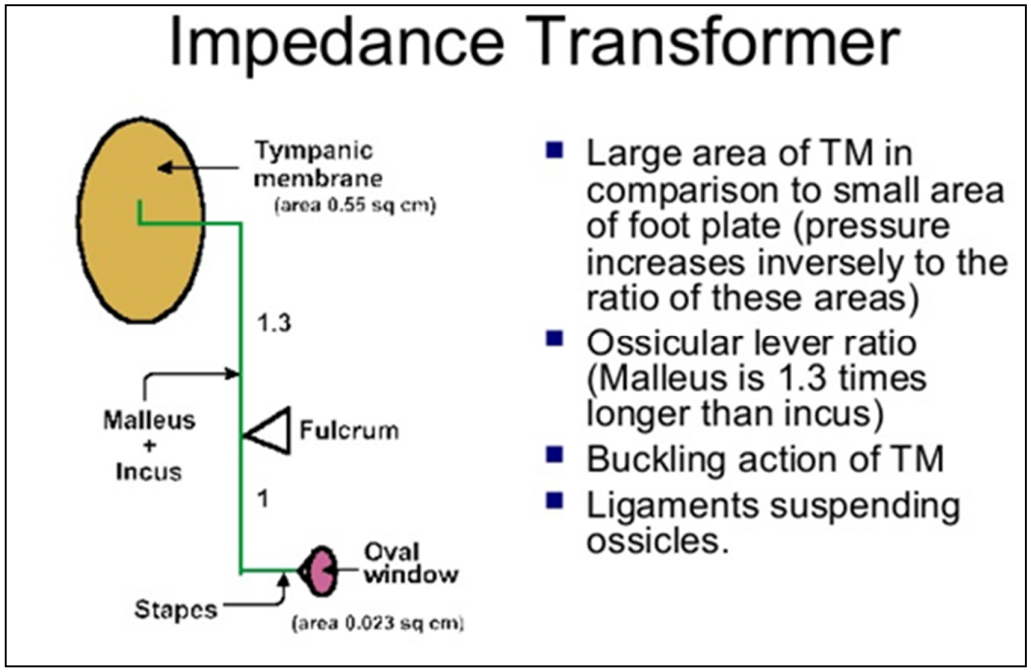
and is normally reached by the age of seven. At an angle of 45 degree, it runs downwards from the middle ear and is turned forwards and medially.

The tube is connected at their apices can be considered consisting of two unequal cones. From the anterior wall of the tympanic cavity arises the lateral third bony portion and it joins the cartilaginous medial part, which makes two-thirds of the tubal length. Its narrowest portion is called the isthmus. The respiratory mucosa containing mucous glands and goblet cells, lines the epithelium on its floor, having a carpet of ciliated epithelium. The mucosa is respiratory at its nasopharyngeal end and towards the middle ear passage of the tube, the number of glands and goblet cells decreases, and less profuse becomes the ciliary carpet. About 12 mm long is the bony portion and in the anterior wall of the tympanic cavity is widest at its oval-shaped orifice. It runs through the petrous and squamous portions of the temporal bone, tapering gradually to a diameter of only 0.5 mm or less in the isthmus. The roof is formed by thin plate of bone separating the Eustachian tube from the tensor tympani muscle above. Medially lies the carotid canal which may impinge on the Eustachian tube in its bony portion. The tube is triangular or rectangular in cross section, with the diameter being the greater horizontally".

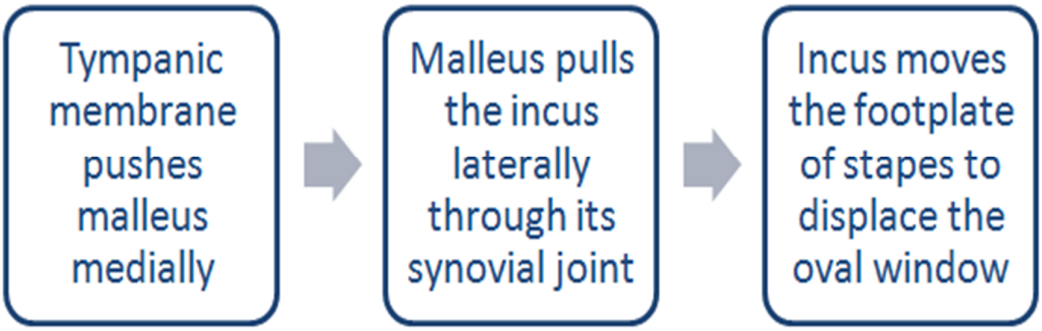
“The length of the cartilaginous portion of the tube is about 24 mm and consists of fibro-cartilaginous skeleton to which is attached the peri-tubal muscles. The cartilage is bent over resembling an inverted T at its upper border, thereby forming a shorter lateral cartilaginous lamina and longer medial cartilaginous lamina. The cartilaginous part is fixed to the skull base in a groove between the greater wing of the sphenoid and petrous part of the temporal bone terminating near the root of medial pterygoid plate. The posteromedial(back) wall is composed of cartilage and the anterolateral (front) wall comprises of cartilage and fibrous tissue to the isthmus of the bony portion is attached while the medial end wider portion protrudes into the nasopharynx, lying under the mucosa directly to form the torus tubarius. The tube opens 1-1.25 cm behind and a little below the posterior end of the inferior turbinate in the nasopharynx .The opening of the Eustachian tube is almost triangular in shape and is surrounded by the torus above and behind. From the lower part of the torus downwards to the wall of the nasopharynx stretches the salpingopharyngeal fold. Immediately below the opening of the tube the levator palati, results in a small swelling as it enters the soft palate. Fossa of Rosenmuller or pharyngeal recess is behind the torus tubaris”.

PHYSIOLOGY

- “Pinna collects the sound from the external environment and has a minor role in the process of hearing. About 5dB of speech frequencies are worsened by the loss of pinna.
- The external auditory canal protects the tympanic membrane from direct damage by its curvature, which also enhances the ear canal characters physically thus enhancing the sound pressure reaching the tympanic membrane.
- The sound pressure collected over the larger area of tympanic membrane (the ear drum) is being transferred to the smaller area of stapes foot plate enhancing the oval window sound pressure.
- The flexibility of the tympanic membrane buckles in response to sound and this helps in impedance matching, thus increasing the force transferred to the handle of malleus and improvement of impedance by factor 4”.



"The malleus and incus are suspended from by ligaments which reduces mass and inertia, producing lever effect. The long process of the incus is shorter than malleus handle and this results in lever action thus converting the low pressure with long lever action at the handle of the malleus to high pressure with a short lever action at the tip of the long process of the incus to the foot plate of the stapes subsequently improving the impendance ratio by factor 1.3".



Conduction of sound from external environment to inner ear requires an intact tympanic membrane and ossicular chain.

ACQUIRED CAUSES OF HEARING LOSS DUE TO DEFECT IN CONDUCTIVE APPARATUS

"External ear- Obstruction caused by wax, foreign body, furncle , acute inflammatory swelling, benign or malignant lesions of the canal.

Middle ear-

A) Tympanic membrane perforation

B) Fluid in the middle ear either otitis media with effusion or hemotympanum or acute otitis media.

C) Tumours of the middle ear- benign or malignant

D) Ossicular chain pathology either disruption or fixation

E) Obstruction of Eustachian tube"

AVERAGE HEARING LOSS IN VARIOUS LESIONS OF CONDUCTIVE APPARATUS

i. "Complete ear canal obstruction - *30dB*

ii. Tympanic membrane perforation which varies with the size of the perforation - *10 to 40 dB* loss.

iii. Intact drum with ossicular interruption - *54 dB*

iv. Ossicular interruption with tympanic membrane perforation - *38 dB*

v. Oval window closure - *60 dB*"

CAUSES OF TYMPANIC MEMBRANE PERFORATIONS

Infections:

A) **Bacterial**-Infection of the middle ear caused by the bacterial infections by beta-hemolytic streptococci leads to acute otitis media resulting in small perforation through which the pus drains. Usually the perforation heals spontaneously unless complications coexist. Eustachian tube dysfunction is the primary factor resulting in permanent perforation.

B) **Mycobacterial**- caused by Myc.tuberculosis and by atypical mycobacteria to a lesser extent. This usually presents as a relentless, low grade inflammation of the tympanic membrane refractory to conventional antibiotic treatment. It results in multiple perforations (sieve like) that eventually coalesce in course of time ".

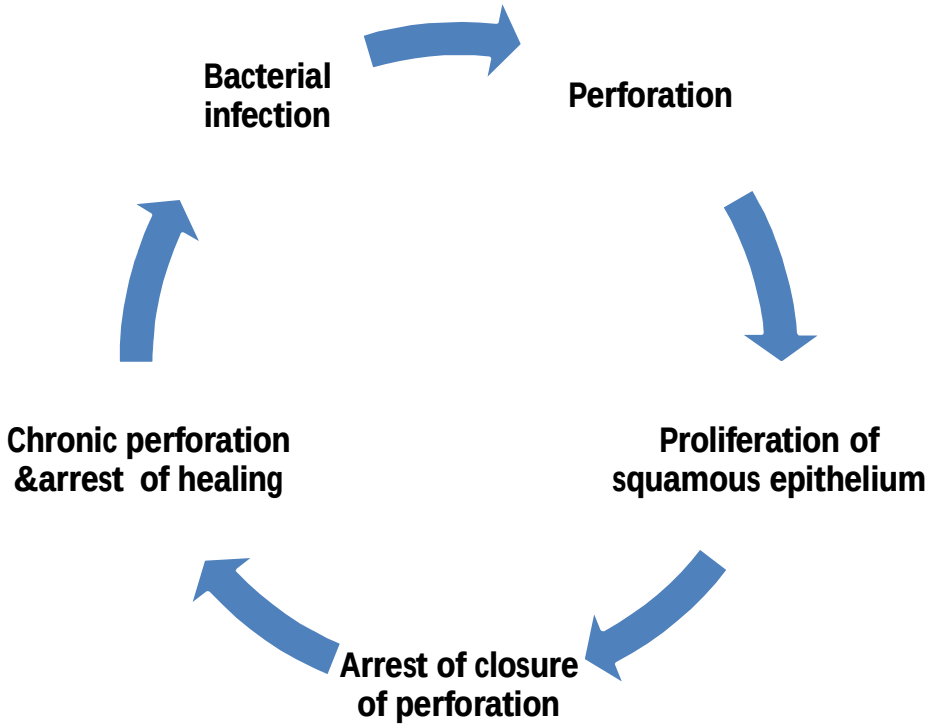
TRAUMA:

A) "*Penetrating*: Manipulation of the ear canal by deep probing using cotton swab, hot slag seen in welders.

B) *Blunt trauma*: Blasts, firearm discharges, lightening strikes or a slap directly to the auricle.

C) *Surgical*: The most common is tympanostomy tube insertion. Others are exploratory tympanotomy, trans-canal stapedectomy".

PATHOLOGY OF TYMPANIC MEMBRANE PERFORATION



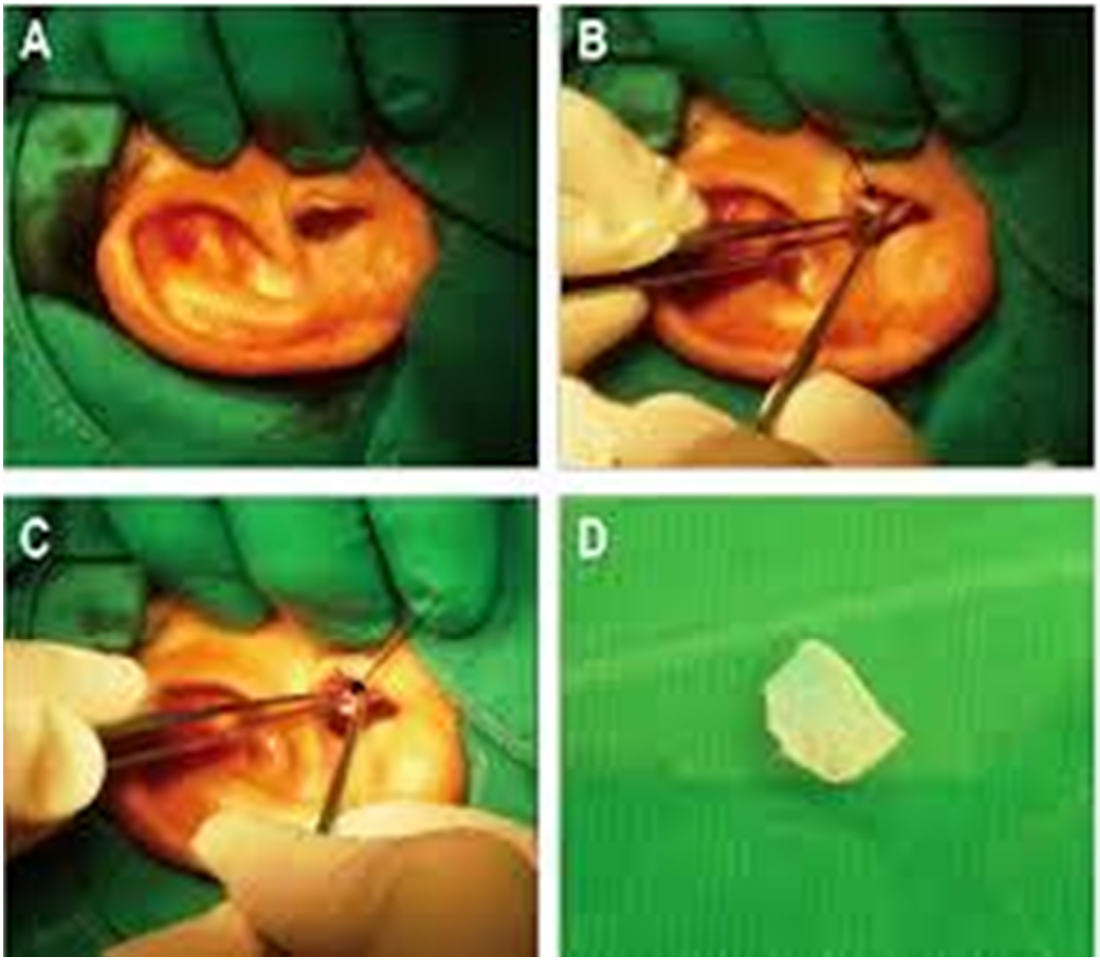
CARTILAGE SHIELD TYMPANOPLASTY TECHNIQUE AND METHOD OF GRAFTING

"Total tympanic membrane replacement with cartilage (cartilage "shield" tympanoplasty) has proved very useful in atelectatic ears, previous tympanoplasty failures, and cases with suspected eustachian tube dysfunction.

Cartilage is removed either from the posterior aspect of the tragus or the concha by using sharp and blunt dissection. Sized to the dimensions of the tympanic membrane defect, the cartilage graft is stripped of its perichondrium, and sliced. At the upper portion of the cartilage graft a wedge is removed to accommodate the handle of the malleus. Then the middle ear is packed with Gelfoam, the cartilage graft is placed medial to the handle of the malleus and the tympanic sulcus. Lateral to the cartilage an areolar tissue graft is placed, medial to the edges of the perforation and posteriorly onto the canal wall.

Cholesteatoma of the pars flaccida -superior portion of tympanic membrane – produces erosion of scutum. To prevent the re-retraction and formation of cholesteatoma repair of the external auditory canal is necessary through the canal defect. It can be accomplished either by a composite cartilage graft or a sleeve of fascia and bone pâté. From the base of the tragus, cartilage harvested is useful for cartilaginous repair. To match the bony defect after the carving of the cartilage the perichondrium is left attached to one side of the cartilage. The composite cartilage graft is inserted to the defect after elevation of the tympanomeatal flap and eardrum from the lateral surface of the malleus handle. The perichondrium faces the elevated skin in such a manner the

graft is positioned so that the eardrum is in the lateral aspect, and the defect is filled by the cartilage” .



A vertical incision is made 5mm behind the anterior border of the posterior surface of the tragus and cartilage is harvested. This picture depicts the harvesting of the cartilage from the tragus.

CHARACERISTIC FEATURES OF IDEAL GRAFT

1) It should be easily available.
2) Inexpensive.
3) Easy to mould.
4) Inert and non toxic.
5) Minimum extrusion rate and absorption rate.
6) Should not induce any foreign body reaction.
7) Immune competent.
8) 15dB of bone conduction hearing improvement.

Cartilage shield graft placed over ossicles. Fascia or perichondrial graft is then placed over the cartilage to complete the reconstruction of the drum.

Cartilage shield graft placed over ossicles as a shield during reconstruction.

Advantages of cartilage composite graft

- The scar is invisible as it is in the posterior aspect of tragus or concha.
- It has all the advantages of the temporalis fascia graft.
- Available locally similar to temporalis fascia.
- The harvested cartilage is easy to handle, provides resistance from infection and firm scaffolding.
- Both ears can be done at the same time.
- Displacement and lateralisation of the graft is very minimal.
- Occurrence of retraction pockets and chances of perforation are reduced.

Harvested cartilage with perichondrium on its surface.

“CLASSIFICATION OF CARTILAGE TYMPANOPLASTY

GROUP A: CARTILAGE TYMPANOPLASTY WITH PALISADES, STRIPS AND SLICES

1. Cartilage palisades in underlay tympanoplasty techniques.
2. Cartilage palisades in on-lay tympanoplasty techniques
3. Tympanoplasty with broad cartilage palisades.
4. Cartilage strips in underlay tympanoplasty techniques.
5. Cartilage strips in on-lay tympanoplasty techniques.
6. Dornhoffer underlay cartilage slice mosaic tympanoplasty

GROUP B: CARTILAGE TYMPANOPLASTY WITH FOILS AND THIN PLATES AND THICK PLATES

7. Underlay tympanoplasty with cartilage foils and thin plates.
8. Onlay tympanoplasty with cartilage foils and thin plates.
9. On-lay tympanoplasty with thick cartilage plates.
10. Underlay tympanoplasty with thick cartilage plates.

GROUP C: TYMPANOPLASTY WITH CARTILAGE-PERICHONDRIUM COMPOSITE ISLAND GRAFTS

11. Superior island cartilage-perichondrium island graft tympanoplasty

12. Posterior cartilage-perichondrium composite island graft tympanoplasty.
13. Superior and posterior cartilage-perichondrium composite island graft tympanoplasty.
14. Total pars tensa cartilage-perichondrium composite island graft
15. Tympanoplasty

GROUP D: TYMPANOPLASTY WITH SPECIAL TOTAL PARS TENSA CARTILAGE-PERICHONDRIUM COMPOSITE GRAFTS

16. Annular cartilage-perichondrium composite graft tympanoplasty.
17. Crown cork cartilage perichondrium composite graft tympanoplasty
18. Cartilage shield T-tube tympanoplasty

GROUP E: CARTILAGE PEICHONDRIUM COMPOSITE ISLAND GRAFT TYMPANOPLASTY FOR ANTERIOR, INFERIOR, AND SUBTOTAL PERFORATION.

19. Underlay tympanoplasty techniques with cartilage perichondrium composite island graft.
20. In-lay underlay tympanoplasty techniques with cartilage-perichondrium composite island graft.

21. On-lay tympanoplasty techniques with cartilage-perichondrium composite island graft
22. In-lay on-lay tympanoplasty techniques with cartilage-perichondrium composite island graft.

GROUP F: SPECIAL CARTILAGE TYMPANOPLASTY METHODS

23. In-lay butterfly cartilage tympanoplasty.
24. Composite chondoperichondrial clip tympanoplasty: The triple "C" technique."

"SITES OF HARVESTING OF THE CARTILAGE"

1) "Harvesting from the tragal cartilage
2) Harvesting from the auricular fossa
3) Harvesting from the triangular fossa
4) Harvesting from the cymba concha
5) Harvesting from the concha"

"Heerman harvested cartilage from the tragus often".

Harvested cartilage with perichondrium on its outer surface.

"Cartilage underlay palisade: Is the oldest and most popular. Palisades are cut often from the tragal cartilage covered on the concave side of the perichondrium. The edges of the perichondrium on the outer side of the palisade are supposed to stick to each other and close the gaps, facilitating the epithelialisation of the tympanic membrane. The superior *'architrave'*, a piece of cartilage placed on to the eminence of the tensor tympani .The inferior end '*simmering'* placed under the bony annulus supported sometimes by a piece of cartilage placed in the anterior part of the hypotympanum. In the posterior part of the tympanic cavity the superior ends of the palisades are supported by the chorda tympani nerve,

incudostapedial joint, stapes head and interposition prosthesis. Cartilage is harvested either from the concha or the tragal cartilage".

"Cartilage palisade on-lay tympanoplasty : is defined as the placement of the cartilage graft on to the denuded lamina propria of the ear drum and onto the fibrous annulus. A belt of squamous epithelium around the perforation is totally removed or partly removed, partly elevated or total elevated. Cartilage can be harvested either from the concha or the scaphoid fossa",

"Cartilage palisade technique is used for the closure of the total perforation. The broad palisades enhances the transmission of the sound waves because of the increased width of the palisades and improved contact with the prosthesis. The cartilage for this procedure can be harvested from the concha or cymba concha.

Cartilage strips in on lay tympanoplasty technique is that it differs from the palisade cartilage tympanoplasty by

1) The strips differ from the palisades in thickness, shapes and cutting.

2) The covering of the strips with the perichondrium is much more sparse tan that of the palisades, which are totally covered on one side.
3) The strips are positioned like roof tiles; the palisades are placed close to each other but still with some small distance between them".

"The on lay technique requires the removal of the epithelium around the perforation. Such methods are delicate and demanding but they represent the minimally invasive surgery, without raising the fibrous annulus. Failure of on-lay myringoplasty is often because of insufficient de-epithelialisation of the ear drum remnant and insufficient covering of the denuded area of the ear drum. Cartilage strips are harvested either from the tragus or concha. The cartilage is harvested covered with perichondrium on both sides".

"The Dornhoffer Cartilage Mosaic tympanoplasty: It differs from the cartilage palisade technique by placing one major full thickness piece of cartilage, in semilunar shape, which is directly under and against the malleus handle or on the top of the malleus or on the top of the prosthesis instead of placing a rectangular strips of cartilage in the side to side manner".

“Underlay tympanoplasty with cartilage foils and thin plates: Cartilage foils are thin slices of cartilage without perichondrium with a thickness of 0.2-0.3mm. The foils and thin plates are cut usually with Kurz precision cartilage knife. The may be of various size and shapes depending on the graft harvested. Closure of a simple dry perforation gives the same good acoustic results as closure with fascia or perichondrium, and same or better anatomical results”.

“On-lay tympanoplaty with thick cartilage plates: The cartilage plates do not have attached perichondrium and used as reinforcement of the ear drum, either of the entire ear drum or parts of it. At the end of the procedure the cartilage plates will be usually covered with fascia or with free perichondrium. The cartilage plates are not suspended by the perichondrium flaps, as are the cartilage-perichondrium composite island grafts, which is the most important characteristic feature of cartilage plates. After the cartilage palisade technique,on-lay cartilage plate tympanoplasty is the oldest method”.

“Underlay tympanoplasty with thick cartilage plates: In this method the cartilage plates of various thickness 0.5-1.1mm but without attached perichondrium, are placed as a re-inforcement of the ear drum or under a part of the ear drum. Often the cartilage plates are covered either

with fascia or free perichondrium, or with areolar tissue from the temporal region".

"Superior(or Attic) cartilage- Perichondrium composite Island graft tympanoplasty": It is defined as around, semiciercular,or other shaped cartilage plate with attached perichondrium on one side. The perichondrium flaps surround the cartilage. The lateral flap is the largest and its placed on to the lateral wall of the ear canal. The medial flap is shortest and placed onto the short process of the malleus and under the superior part of the ear drum.

"Posterior cartilage-perichondrium composite Island graft tympanoplasty: The posterior cartilage-perichondrium composite island graft covers the posterior perforation, most often a perforation after removal of the posterior retraction. The large anterior perichondrium flap is originally placed under the malleus handle and the anterior part of the ear drum. The posterior perichondrium flap is placed on to the ear canal bone".

"Superior and Posterior Cartilage perichondrium composite Island graft tympanoplasty: Attic retraction can sometimes co-exist with posterior retraction of the pars tensa. In such cases cartilage

perichondrium composite graft can be shaped in such a way that both the attic and pars tensa retractions can be covered with a single graft".

"Total Pars tensa cartilage-perichondrium composite Island Graft tympanoplasty: The total pars tensa cartilage-perichondrium composite island graft consists either of one round disk or of two semicircular cartilage disks, or even of four disks, covered laterally by the perichondrium. The perichondrium also surrounds the cartilage as a 1-4mm wide peripheral flap, which will be placed onto the denude ear canal bone. The cartilage disk is suspended by the perichondrium flap".

"Annular cartilage-Perichondrium composite graft tympanoplasty: The annular cartilage –perichondrium composite graft is 1.5-3mm wide, horseshoe-shaped or circular or U-shaped cartilage ring attached to the perichondrium, which continues as a circumferential peripheral extension. The cartilage ring of the annular graft is placed either onto the fibrous annulus or onto the bony annulus or onto the bony annulus or into the tympanic cavity at the level of the bony annulus. The perichondrium serves as the ear drum and is placed either under or onto the malleus handle. The peripheral perichondrium is placed on to the bone of the ear canal, suspending and stabilising the cartilage ring".

“Crown cork” cartilage-perichondrium composite graft tympanoplasty: The total reconstruction of the tympanic membrane with a cartilage-perichondrium composite graft, called “crown cork” tympanoplasty. The graft consists of around piece of tragal cartilage, covered on the outer side (ear canal side) with perichondrium, which continues in a large peripheral perichondrium flap. The diameter of the cartilage is slightly smaller than the diameter of the ear canal at the level of the bony annulus. The exposed, bare inner side of the cartilage is brought into contact either with malleus handle or with a PORP or TORP prosthesis. The large overlapping peripheral perichondrium is radially incised, resulting in several perichondril flaps,which,after placement and fixation on the ear canal bone, form the shape of a crown cork”.

“Cartilage shield T-Tube Tympanoplasty: After a tympanotomy with elevation of the posterior tympanomeatal flap with the intact ear drum, the cartilage-perichondrium graft with the T-tube is placed into the postero-inferior part of the tympanic cavity and the small perichondrium flap onto the postero-inferior part of the ear canal. The goal of the placement of the permanent tube is to prevent repeated insertions of the ventilating tubes, especially in children with severe and chronic secretory otitis media”.

“Underlay tympanoplasty techniques with cartilage-perichondrium composite island graft: The cartilage –perichondrium composite island graft is defined as a piece of tragus or conchal cartilage,covered on one side with perichondrium,which surrounds the cartlage as a flap”.

“In-lay underlay tympanoplasty techniques with cartilage-perichondrium composite island graft: The in-lay underlay composite graft consists of a cartilage disk and a relatively large perichondrium flap. The cartilage disk is placed under the ear drum remnant. The difference between the in-lay on-lay graft is the position of the perichondrium flap: in the in-lay on-lay method the perichondrium is placed onto the denuded ear drum remnant. In the in-lay underlay technique the graft is positioned under the ear drum remnant”.

“On-lay tympanoplasty techniques with cartilage – perichondrium composite island graft: The on-lay composite cartilage perichondrium composite graft has a cartilage disk slightly larger than the perforation. The disk is covered on the convex side with the perichondrium flap”.

“In-lay On-lay tympanoplasty techniques with cartilage – perichondrium composite Island graft: It consists of a cartilage disk that is placed into the perforation. On the ear canal side the cartilage is covered with perichondrium, which surrounds the cartilage as a1-2mm wide flap. The cartilage disk I positioned in the perforation and the perichondrium flap is placed onto the margin of the de-epithelialized lamina propria around the perforation”.

“In-lay butterfly cartilage tympanoplasty: It involves placing a specially shaped cartilage-perichondrium composite graft both under and onto the ear drum. This technique is partly underlay and partly onlay. The circumferential incised edges of the cartilage curl apart,like wings of a butterfly and hence its name”.

“Composite chondroperichondrial flap clip tympanoplasty: The graft is both onlay and underlay graft. The diameter of the graft should be larger than the size of the perforation, allowing elevation of the 1mm belt of the perichondrium, allowing elevation of a1mm belt of the perichondrium along the periphery of the graft. After removing the epithelium surrounding the perforation, the graft is placed the edge of the perforation and the cartilage disk is carefully rotated under the ear drum.

The perihondrium is placed onto the denuded ring of the eardrum and the cartilage hangs from the perichondrium".

PRINCIPLES OF CARTILAGE TYMPANOPLASTY

1) Establishing communication between the drum and inner ear fluid to restore the middle ear transfer mechanism.
2) Creating a new middle ear volume with equals near normal
3) Achieving mobility of the newly formed neo-tympanum.
4) Preventing the rate of extrusion rate, assessing the functional capacity and also improving the functional capacity of the middle ear.

EFFECTS OF TYMPANIC MEMBRANE PERFORATION ON HEARING

" Reduced surface area of the tympanic membrane on which sound pressure is exerted, results in dampening of the ossicular chain excursion. The larger the tympanic membrane perforation, the greater is the loss of surface area of the ear drum on which the sound pressure can act, with that sound pressure entering the middle ear through the perforation as an additional factor can act on the tympanic membrane posterior surface against the sound pressure on outer surface. In addition site of the tympanic membrane perforation influences the degree of hearing loss,

thus posterior perforations can produce more severe hearing loss than the anterior one.

Sound reaches directly the round window without dampening and phase changing effect of an intact tympanic membrane. Moreover as the size of the tympanic membrane remnant is decreased, the hydraulic advantage produced by a larger tympanic membrane on smaller oval window disappears, so that sound reaches both oval and round windows with more nearly at the equal time and nearly equal force. The maximum hearing loss observed with the resultant cancellation of vibratory movement of the cochlear fluid column producing as much as 45dB for the speech frequencies in case of simple perforation.

In general, the greater the hearing impairment with the larger perforation, but this relationship is neither consistent or constant in our clinical practice; the perforations which are seemingly identical in size and location produce a different degrees of hearing loss."

ADVANTAGES OF CLOSURE OF TYMPANIC MEMBRANE

"Closing a tympanic membrane perforation isolates the middle ear cavity from the external environment and prevents the contamination by exposure to external pathogens introduced through the external auditory canal. Repeated exposure to pathogens can lead to recurrent/frequent,

acute otitis media with consequent permanent alteration of the middle ear mucosa and its sound-transmitting mechanism and or active/chronic otitis media with ear discharge which becomes refractory to treatment.

The vibratory area of the tympanic membrane is restored and afforded by the closure of a tympanic membrane perforation and round window protection, thus hearing improvement and decreasing tinnitus; however, a persistent air–bone gap, is demonstrated by a high-frequency audiometry despite successful perforation closure of tympanic membrane.

An expected improvement from closure of a perforation is obtained by patching with cigarette paper or cellophane temporarily. An presence of an additional ossicular lesion is suspected, either fixation or discontinuity if a carefully applied airtight patch does not eliminate the conductive hearing loss. In such cases, simple myringoplasty will not be enough. Closure of tympanic membrane must be accompanied or followed by correction of the ossicular problem either by tympanoplasty or ossiculoplasty."

Patient Selection

- “Proper history
- Examination of the ear under microscope.
- Head and neck examination to identify risk factors.
- Documentation of the findings, preferably diagramming the perforation.
- Pure-tone audiogram with speech discrimination evaluation.
- Tuning fork tests should be done on all patients to confirm audiogram.
- If there is a suspicion of complications of underlying pathology or separate indicators from the problem at hand such as revision surgery in association with chronic otorrhea.
- Preoperative counselling of the nature of the problem, the proposed treatment and alternative therapies, expected outcome, and potential complications.
- Written explanations and instructions discussing pre- and postoperative care of the ear. Video-taped discussions of the proposed procedure.

The following factors must be considered and dealt with preoperatively”.

Function of the Eustachian Tube

"Assessing the function of the Eustachian tube is little difficult. A normal contralateral ear is the one of the most useful indications of proper Eustachian tube function. With bilateral tubal pathology, decreased rate of success is associated. To preclude surgical intervention lack of Eustachian tube function should not be considered.

After removing the infection and reconstruction of the middle ear space, Eustachian tube function may improve through normalization of the mucosal inflammation seen when the perforation is present".

Infection control

"Control of active infection or eradication in the ear under question is crucial. For proper aural toilet and monitoring of improvement, regular repeat visits in otology clinic is essential and should be considered prior to institution of any surgical procedure. This instillation allows the purulent material getting removed from external canal and the middle ear and thus restores a more physiologic pH. The solution be used at body temperature and it is important so as to avoid the caloric stimulation of the labyrinth. Three drops of an antibiotic ear solution is instilled into the ear following acetic acid irrigation. Systemic oral antibiotics may also be prescribed, depending on the severity of the

infection. Majority of the otorrhea will respond to the local care and the discharge from the draining ears are not routinely cultured. Despite aggressive medical treatment, if the ear continues to drain then, discharge culture and sensitivity testing is performed and appropriately the antibiotic regimen adjusted. Most patients will respond to this mode of treatment. Other factors such as patient compliance, or incomplete treatment of the offending organisms, mastoid involvement, severe allergies are considered if the treatment fails".

Antibiotics

"In the absence of signs of active infection (purulent ear discharge), the administration of systemic antibiotics perioperatively does not influence the results of the surgery tympanoplasty. Emergence of bacterial pathogens in the postoperative period is not prevented by peri-operative antibiotics .The presence of non purulent otorrhea preoperatively, similarly does not indicate the presence of pathogenic bacterial flora in the middle ear cavity and the external auditory canal."

Control of Allergies and Rhinosinusitis

"Prior to surgery identifying and treating the coexistent allergies and sinus disease is important. The Eustachian tube function is affected by the status of the upper respiratory tract directly influencing it,

therefore the eventual outcome of surgery. Therefore, a course of antihistamines and or nasal corticosteroid sprays may be prescribed empirically based on patient's history and clinical examination. Skin testing with targeted desensitization should be considered, if there is a strong history of allergies".

Patient's age

"Adults have higher rate of success when compared to children".

Contralateral Ear Status

"If the only hearing ear is under question , surgery should not to be attempted to repair the tympanic membrane perforation with myringoplasty as there is real risk of sensorineural hearing loss exists with the procedures. A range from 0.1 to 2% is the rate of such hearing loss reported with the attempted procedure. Often by similar pathology the contralateral ear may be involved. Depending on the hearing status, the choice of which ear to be repaired is then decided - first the worse hearing ear should be operated. Pathologic condition in a better hearing contralateral ear threatening hearing or health such as cholesteatoma, active infection such as acute mastoiditis, or significant atelectasis likely to progress to cholesteatoma or erosion of ossicular chain are exceptions to this rule".

Hearing Status/Need for Hearing Aids

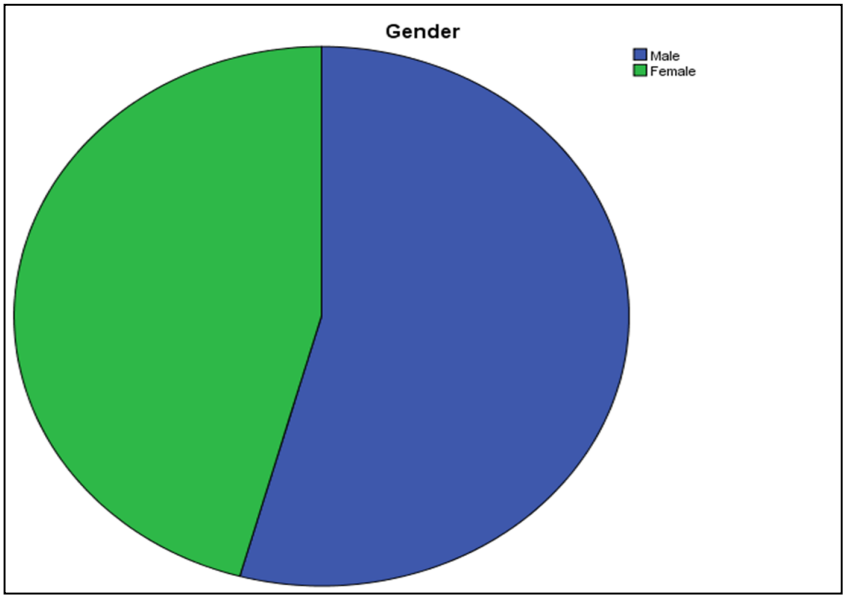
"Purulent otorrhea is a contraindication although wet ear in itself is not a contraindication to perform myringoplasty. If factors such as allergies, Eustachian tube dysfunction and super infection have been controlled, a wet ear should not be an absolute contraindication for the surgery, myringoplasty.

In selected patients, a as an adjunct to the myringoplasty, mastoidectomy may be considered that can improve the success rate".

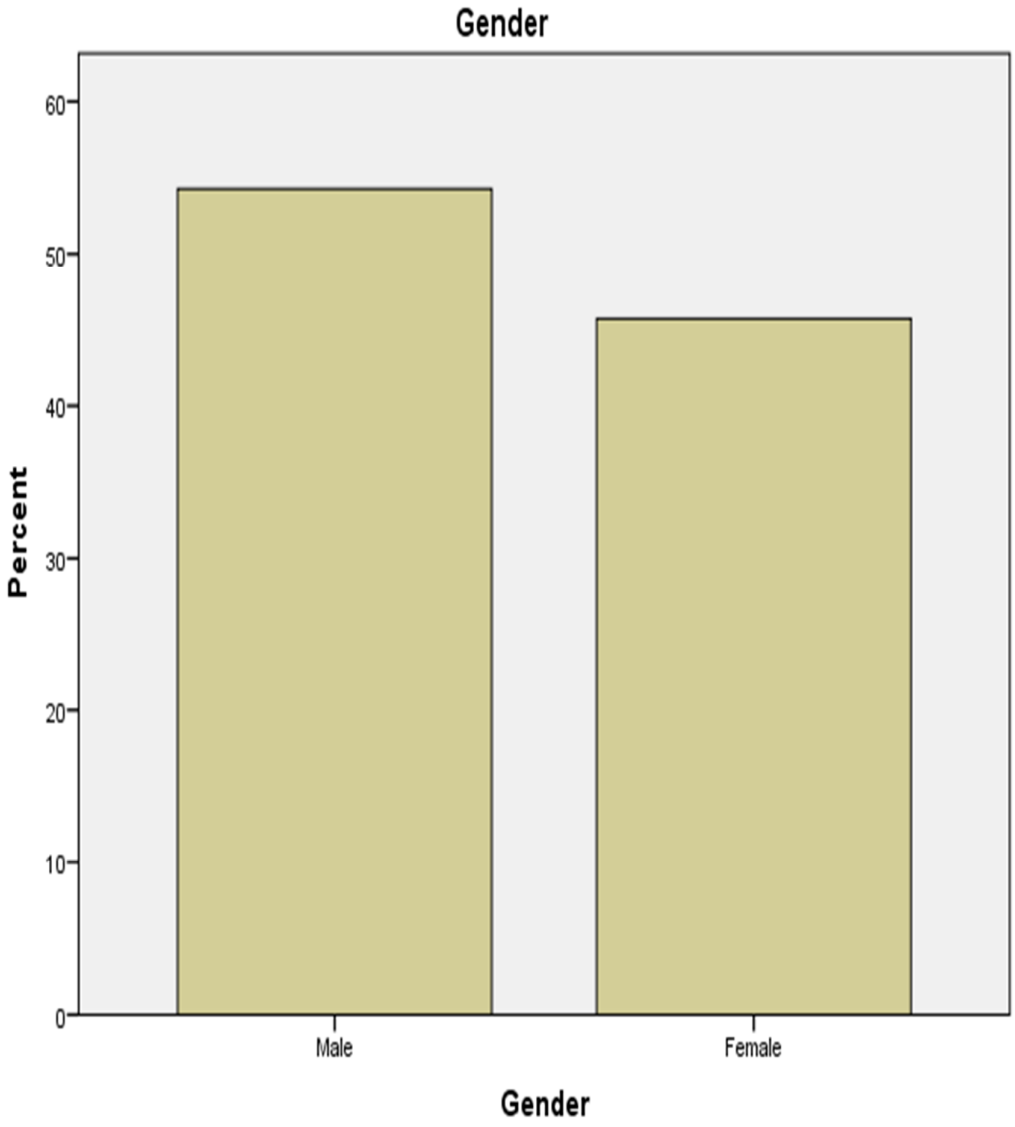
Observation and Results

OBSERVATION AND RESULTS

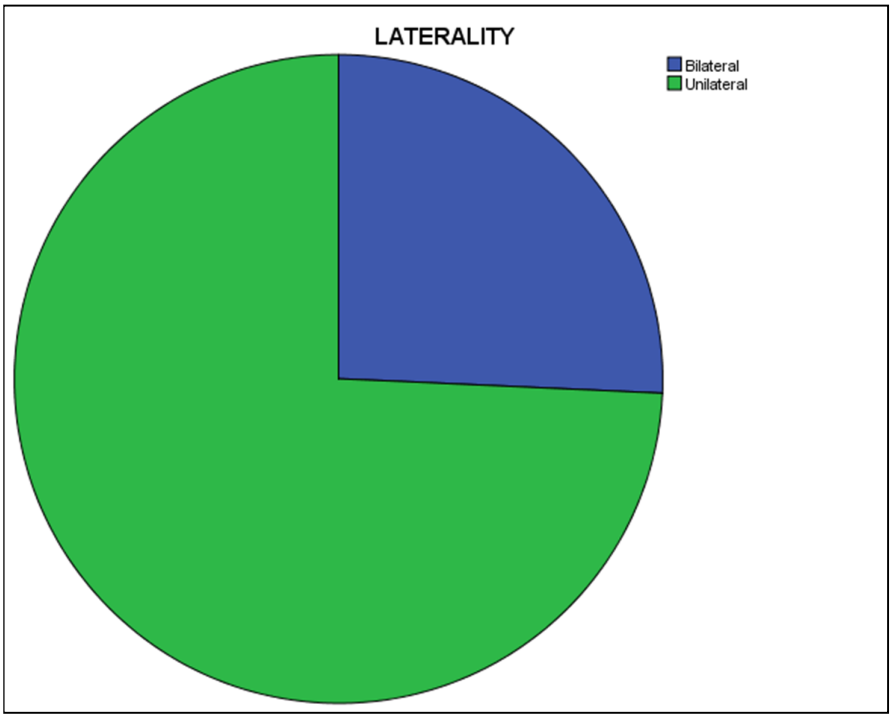
Gender



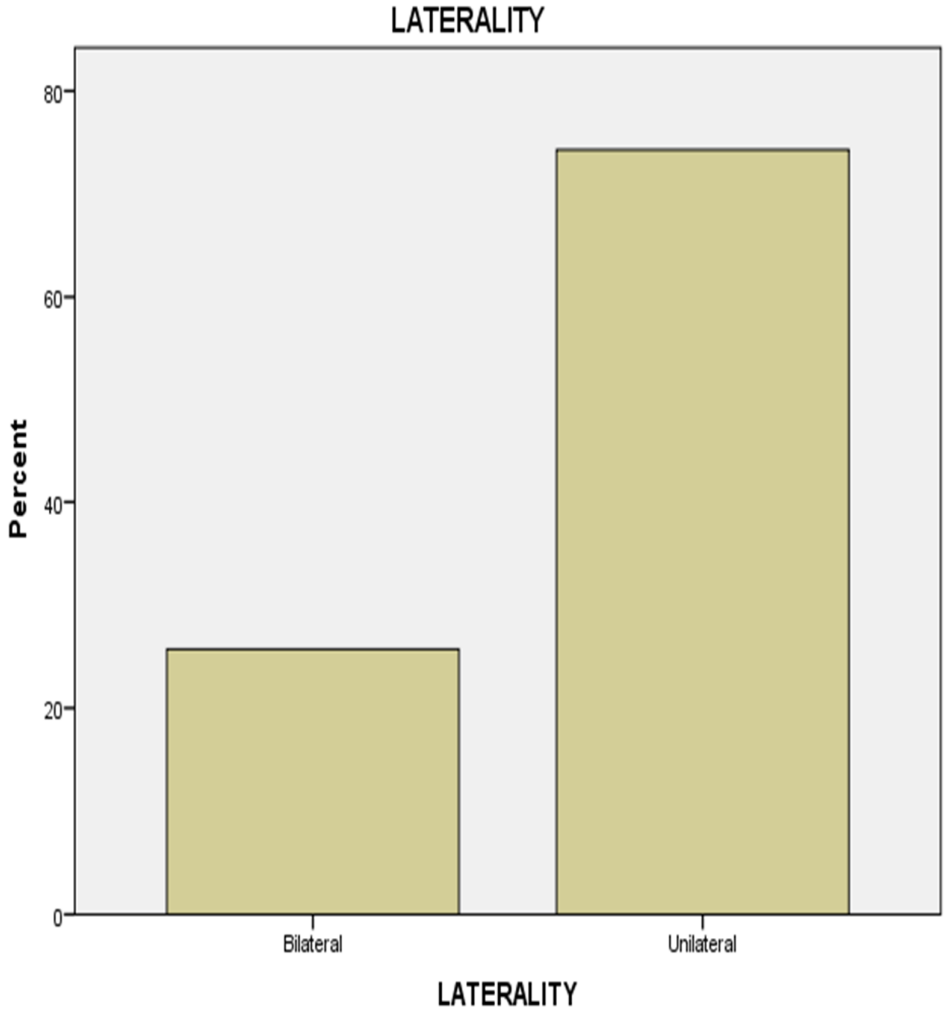
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	19	54.3	54.3	54.3
	Female	16	45.7	45.7	100.0
	Total	35	100.0	100.0	


Gender
Percent
60
50
40
30
20
10
0
Male
Female
Gender

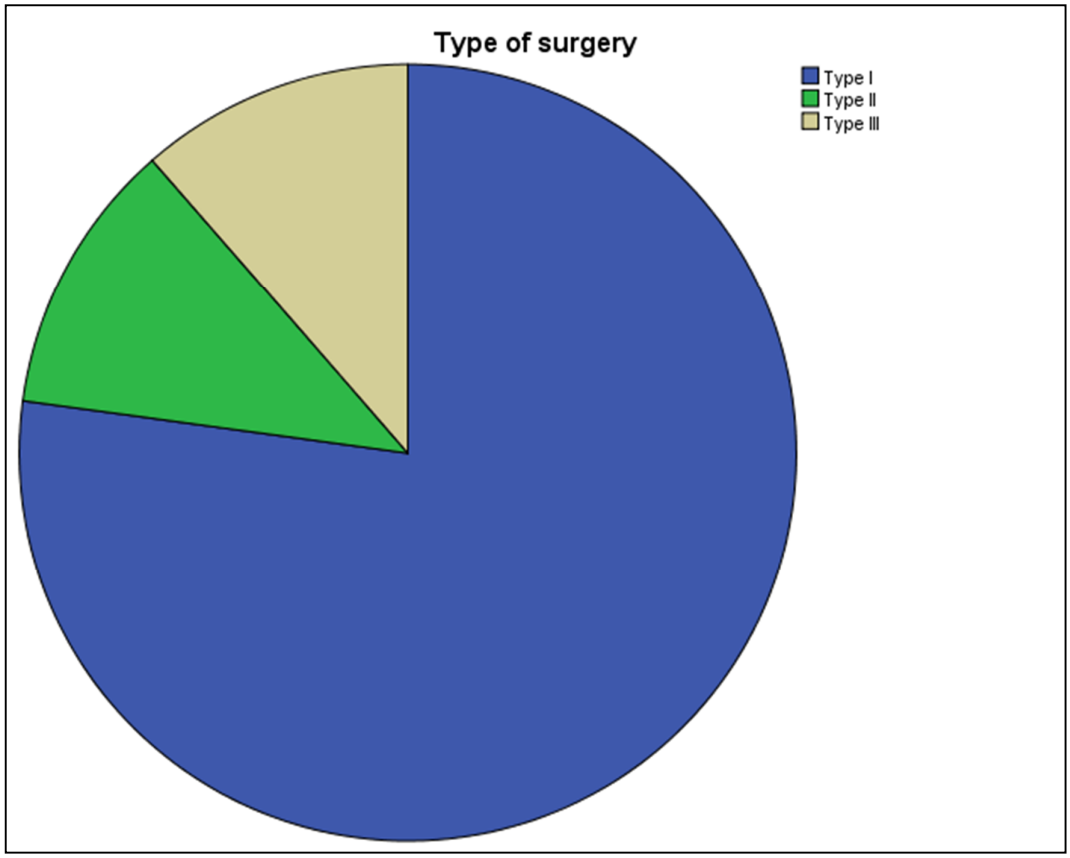
LATERALITY



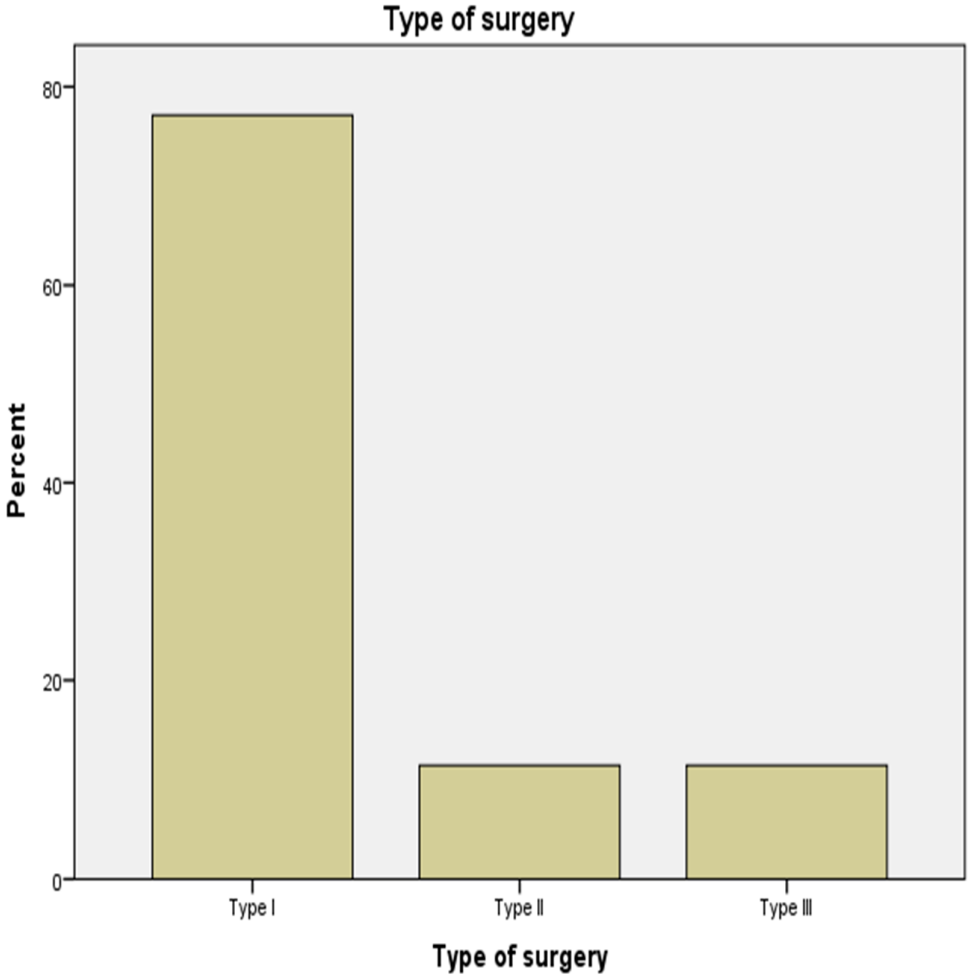
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bilateral	9	25.7	25.7	25.7
	Unilateral	26	74.3	74.3	100.0
	Total	35	100.0	100.0	


LATERALITY
Percent
80
60
40
20
0
Bilateral
Unilateral
LATERALITY

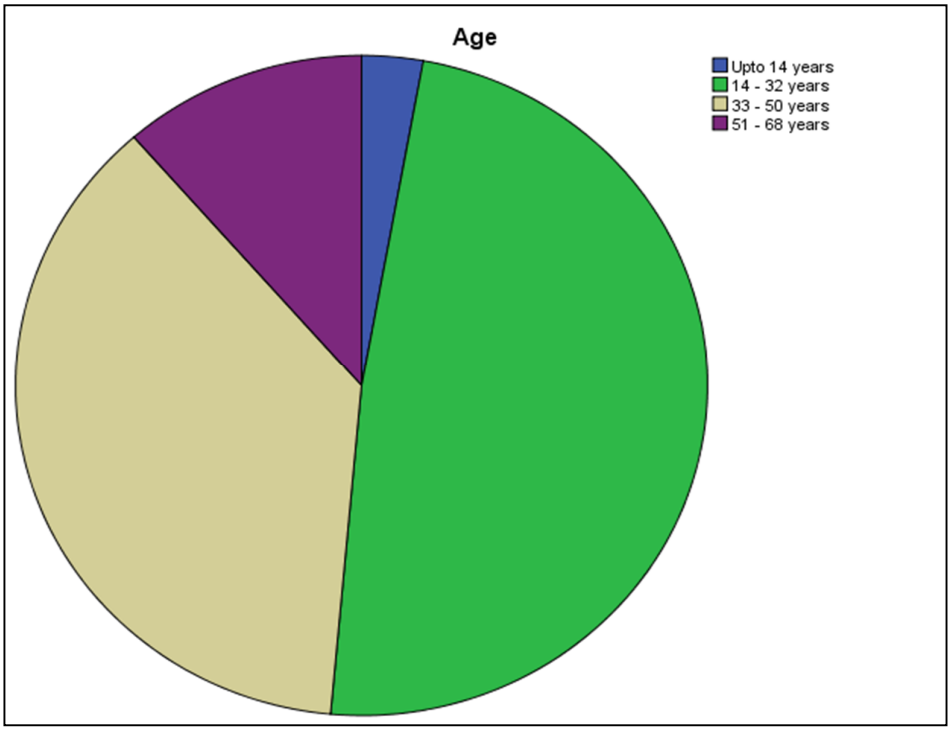
Type of surgery



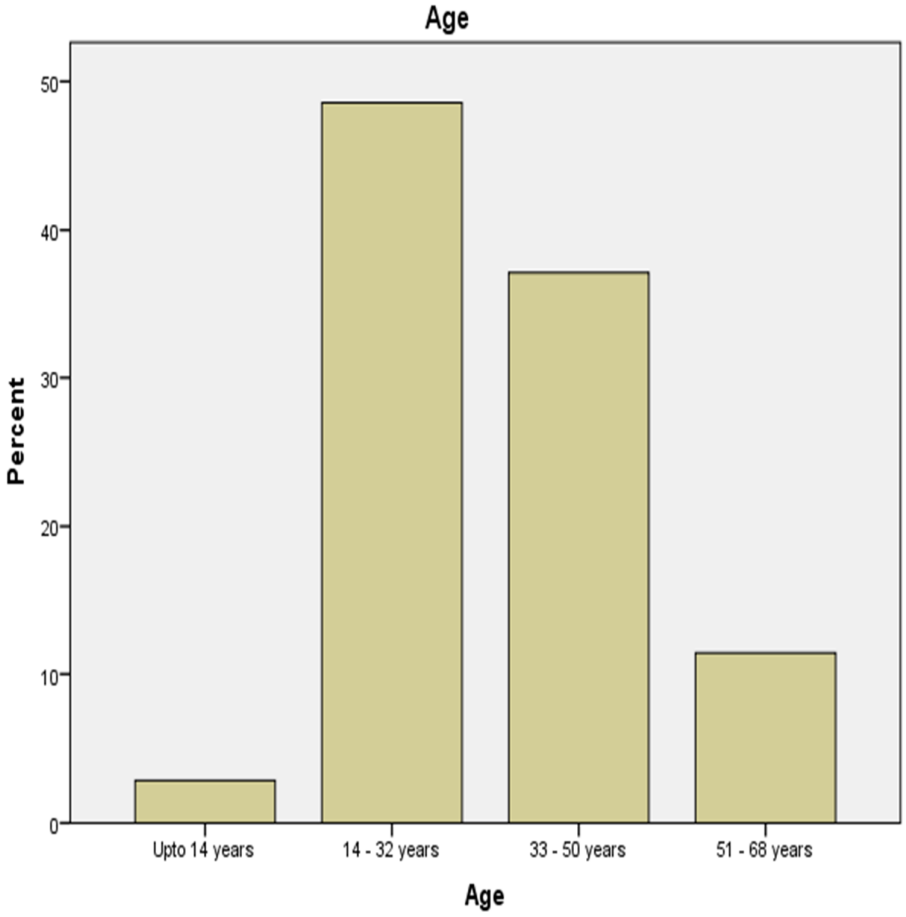
Type of surgery				
	Frequency	Percent	Valid Percent	Cumulative Percent
Type I	27	77.1	77.1	77.1
Type II	4	11.4	11.4	88.6
Type III	4	11.4	11.4	100.0
Total	35	100.0	100.0	


Type of surgery
Percent
80
60
40
20
0
Type I
Type II
Type III
Type of surgery

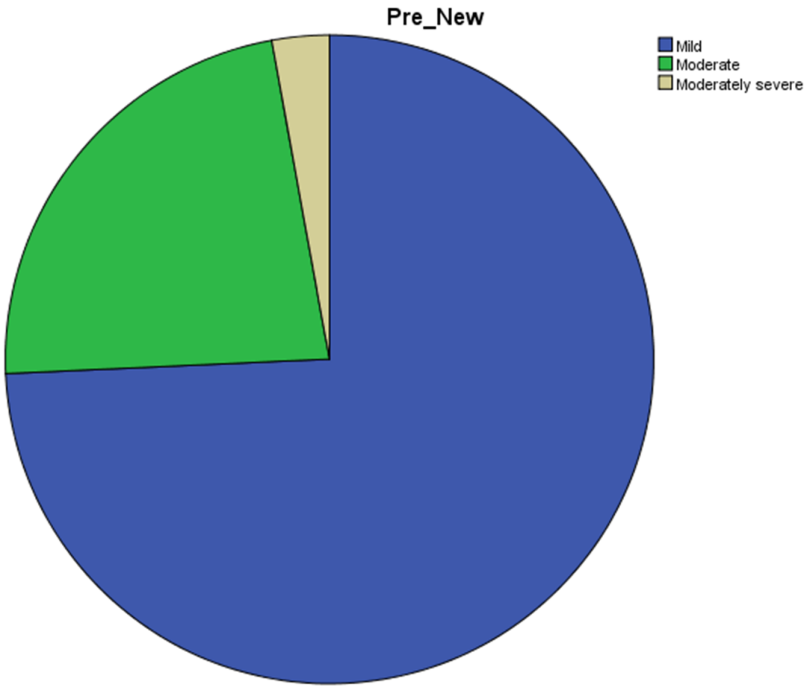
Age



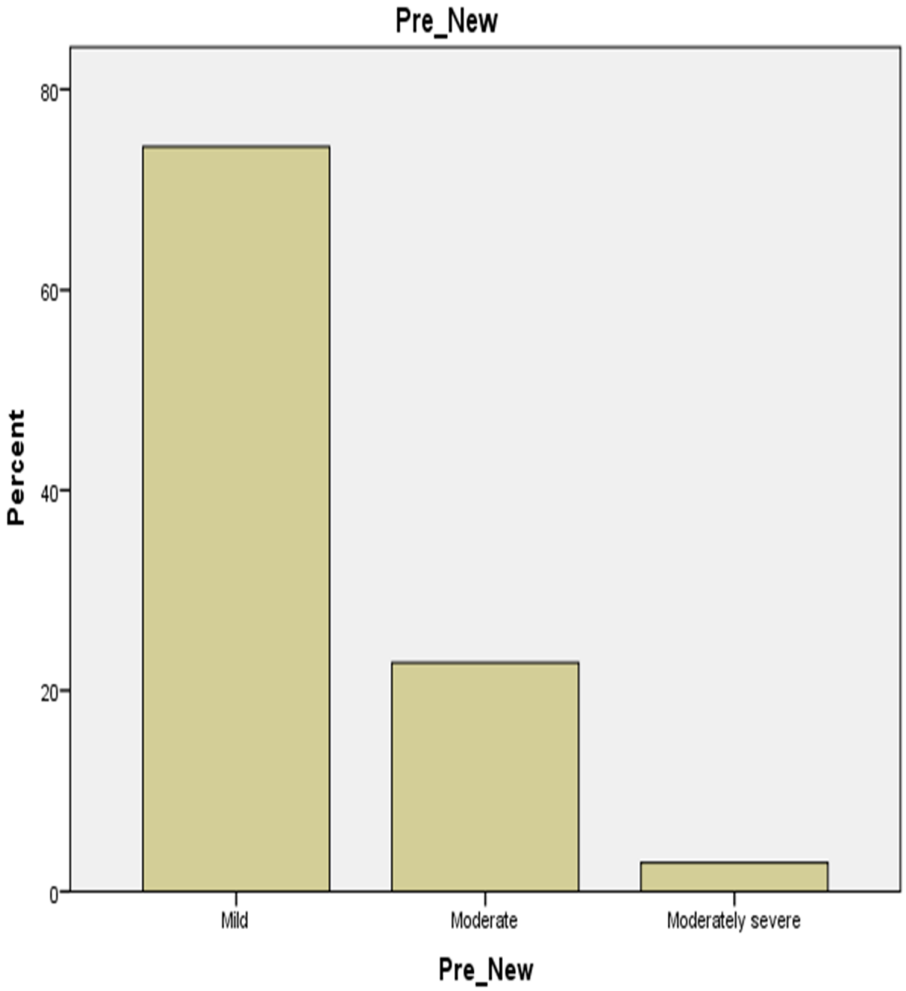
	Frequency	Percent	Valid Percent	Cumulative Percent
Upto 14 years	1	2.9	2.9	2.9
14 - 32 years	17	48.6	48.6	51.4
33 - 50 years	13	37.1	37.1	88.6
51 – 60 years	4	11.4	11.4	100.0
Total	35	100.0	100.0	


Age
Percent
50
40
30
20
10
0
Upto 14 years
14 - 32 years
33 - 50 years
51 - 68 years
Age

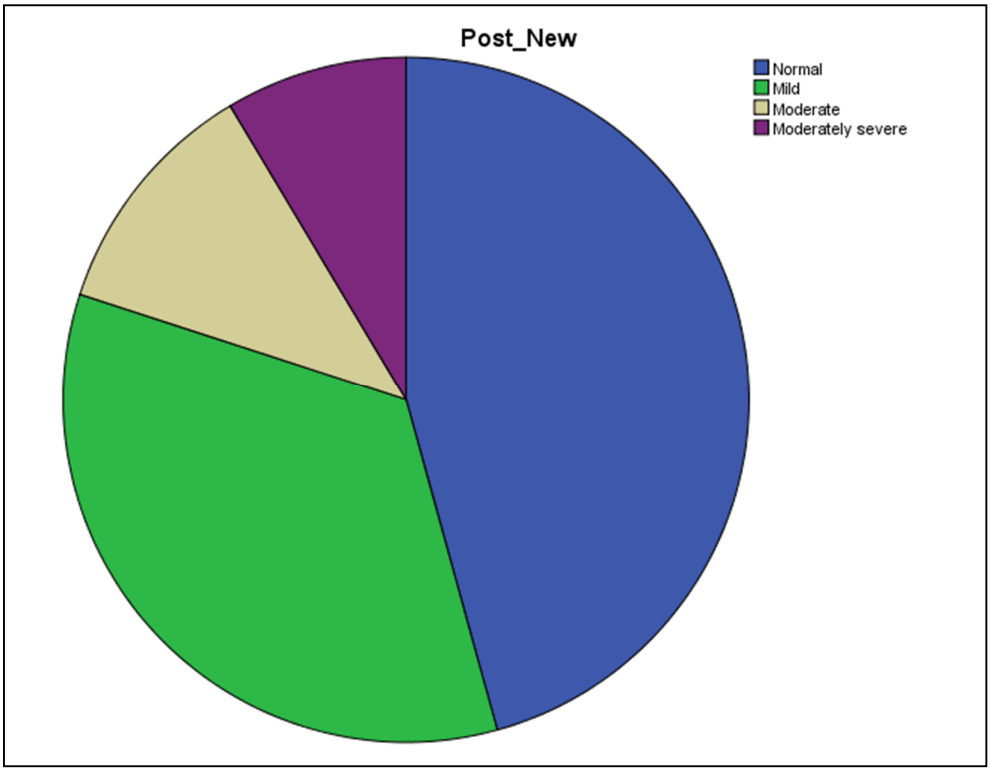
Pre new



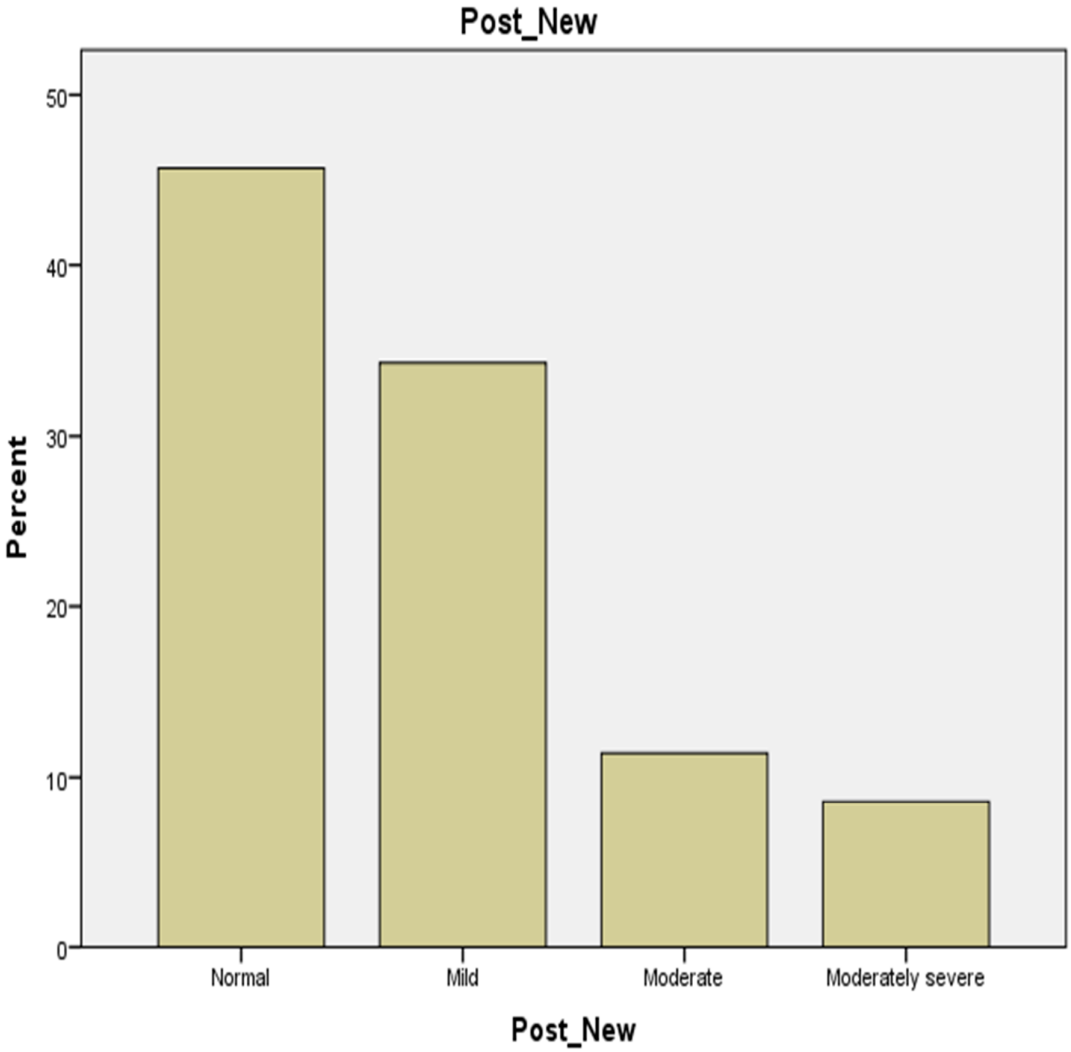
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mild	26	74.3	74.3	74.3
	Moderate	8	22.9	22.9	97.1
	Moderately severe	1	2.9	2.9	100.0
	Total	35	100.0	100.0	


Pre_New
80
60
40
20
0
Percent
Mild
Moderate
Moderately severe
Pre_New

Post_New



	Frequency	Percent	Valid Percent	Cumulative Percent
Normal	16	45.7	45.7	45.7
Mild	12	34.3	34.3	80.0
Moderate	4	11.4	11.4	91.4
Moderately severe	3	8.6	8.6	100.0
Total	35	100.0	100.0	


Post_New
Percent
50
40
30
20
10
0
Normal
Mild
Moderate
Moderately severe
Post_New

Discussion

DISCUSSION

"Desarda KK, Bhisegaonkar DA, Gill S Tragal perichondrium and cartilage in reconstructive tympanoplasty, Indian Otolaryngology Head Neck Surg, 2005 ; 57 : 9- 12, In this study, they strongly recommended the tragal pericondrium and cartilage composite graft in various tympanoplasty reconstructions. Within15 dB of bone conduction of hearing improvement has become a standard criterion almost for the analysis of surgical success".

"Is cartilage tympanoplasty more effective than fascia tympanoplasty ? A systematic review **:** Tympanoplasty using cartilage with or without perichondrium has better morphological outcome than tympanoplasty using temporalis fascia. However,there was no statistically significant difference in hearing outcomes between the cartilage and temporalis fascia grafts".

"Gerber, et al. studied 11 cartilage and 11 temporalis fascia graft tympanoplasties in 2000. They observed comparable hearing results in both groups".

“Thirty-two cartilage and 32 temporalis fascia graft tympanoplasties were performed by Anderson, et al. in 2004. They observed a 6% TM retraction in the cartilage group and a 36% TM retraction in the temporalis fascia group”.

“In 2004, Gierek, et al. performed 112 cases with cartilage and 30 cases with temporalis fascia. They observed that there was no significant hearing difference between the two groups”.

“Couloinger, et al. observed 59 cartilage graft tympanoplasties and 20 temporalis fascia graft tympanoplasties in 2005 and they reported no postoperative hearing difference between the two groups”.

“Tragal Perichondrium and Cartilage in Reconstructive Tympanoplasty Desarda K. K. Bhisegaonkar D. A. Gill S.,Professor and head department of ORL, KEM hospital, Pune.,Chief residents department of ORL, KEM hospital.This paper was read at AOI conference, Cochin, January 2000.”

“Group A – Myringoplasty

Out of 300 cases onlay grafting was done in 172 cases and inlay grafting was done in 128 cases. The tragal perichondrium and catilage was the choice graft used with excellent post of results. The success rate was 96%. The hearing gain with SRT was achieved within 15 dB AB gap closure. Audiometric thresholds revealed 15–20 dB A–B gap closure. The follow up was achieved in 50% of cases for 2 to 4 years.”

Group B– Ossiculoplasty

In this group, 100 cases were subjected for tympanomastoidectomy with ossicular reconstruction by tragal cartilage and perichondrium struts of various types as L–shape, Bow–shape and Boomrang strut. Various combinations of Incudo–stapedial assembly, malleo–stapes strut, malleo–footplate assemblies were done. In all cases sialistic sheet was used so also the anterior canal skin as covering the graft assembly. In this group the success rate was 84% and failure rate was 16%. The failures were due to infection, prosthesis displacements and extrusion of the graft. Audiometric thresholds revealed 15–20 dB A–B gap closure. The follow up was achieved in 50% of cases for 2 to 4 years.”

“Cartilage Tympanoplasty: the Outcome in 35 Patients 1.C.A.B.M.S. (Otolaryngology), ENT Specialist, Assistant Professor, 2Department of Surgery, College of Medicine, Mosul University,Iraq *Basil M. Saeed”*

“Cartilage tympanoplasty is a reliable and safe technique in the reconstruction of the TM. Hearing results after cartilage tympanoplasty is comparable to a temporalis fascia graft. It is strongly recommended as the primary procedure for the reconstruction of a high risk perforation of the TM.”

“Is Cartilage Tympanoplasty More Effective Than Fascia Tympanoplasty? A Systematic Review Shwan H. Mohamad, Imran Khan, and S. S. Musheer Hussain Department of Otolaryngology, Ninewells Hospital and Medical School, Dundee; and Queen’s Medical Centre, Nottingham, U.K. Tympanoplasty using cartilage with or without perichondrium has better morphological outcome than tympanoplasty using temporalis fascia. However, there was no statistically significant difference in hearing outcomes between the 2 grafts.”

“M Cavaliere et al has published an article "Tragal cartilage in tympanoplasty: Anatomic and functional results in 306 cases" concluded that the use of tragal cartilage has resulted in a significant hearing improvement in the reconstruction of tympanic membrane procedure. In cartilage shield tympanoplasty graft take of has been excellent, hearing results are satisfactory and the complications are minimal. The grafting material of choice is cartilage in cases of more advanced pathological conditions, such as recurrent perforation after myringoplasty, severe attica and/or posterior uncontrolled retraction pocket with cholesteatomatous formation, atelectasis of the tympanic membrane”.

“On account of its acoustic properties, comparable to those of the temporalis fascia, recommended the use of cartilage in less severe middle ear disorders, in which the functional outcome is more essential”.

“Altuna et al. reported that their cartilage tympanoplasty is very effective in revision cases and demonstrated acceptable success rates for grafting and hearing results in high-risk perforations. Their graft success rate was 87”.

"Bozdemir et al. reported better hearing results in temporalis fascia grafting than conchal cartilage grafting. In the present study, satisfactory hearing results were observed. This result may be due to increased stabilization by thinning of the cartilage part of the graft".

FUNCTIONAL HEARING RESULTS ON CARTILAGE TYMPANOPLASTY CAN ALSO BE COMPARED WITH TUBAL FUNCTION PREOPERATIVELY

"Tubal function can be graded into four types based on deflation test and aspiration test.

GRADE 1: Completely positive deflation and aspiration test.

GRADE 2: Positive deflation test and partly positive aspiration test.

GRADE 3: Partly positive deflation test and negative aspiration test.

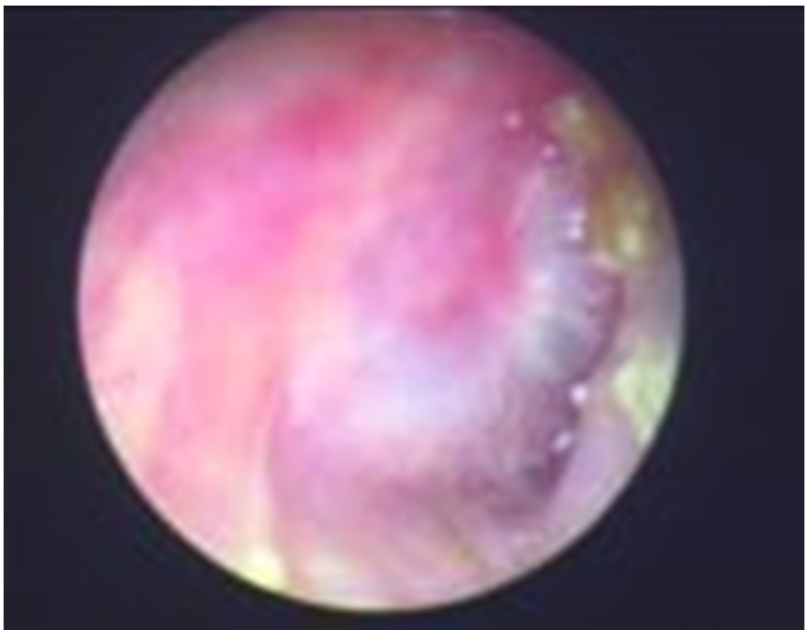
GRADE 4: Negative deflation test and aspiration test".

"After cartilage tympanoplasty, there are three levels of reporting,

1) Cartliage tympanoplasty results are compared with similar series of cartilage tympanoplasty.
2) Results of tympanoplasty performed with cartilage can be compared with temporalis fascia.

3) Reports which is not compared with other similar type of series but pre operative and post operative hearing loss".

Our study come under third category mentioned above.



Post operative endoscopic picture showing good graft take up after three months.

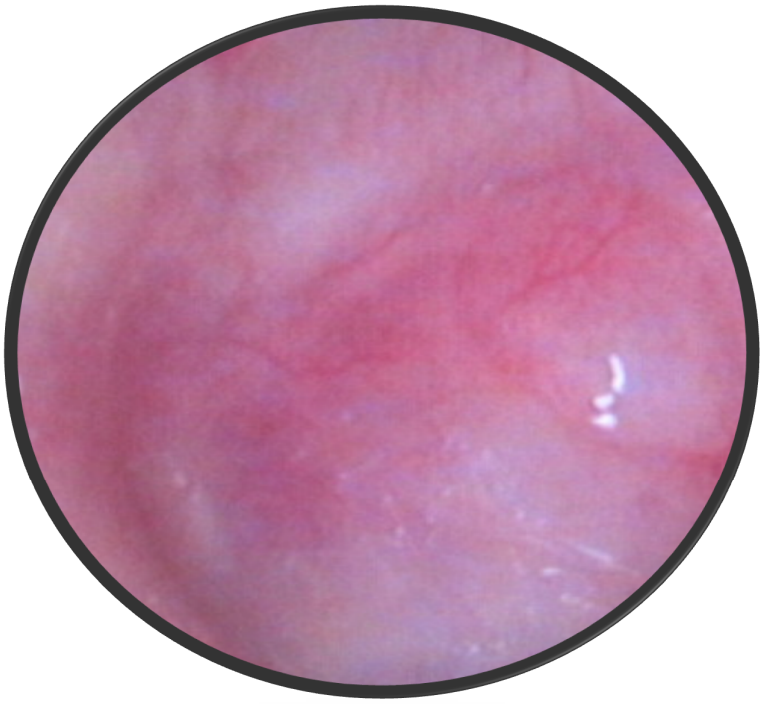
FATE OF CARTILAGE AFTER CARTILAGE TYMPANOPLASTY

"The fate of cartilage after cartilage tympanoplasty was investigated by Yamamoto et al., 6 months post operatively. There was no evidence of any FB reaction or marked changes in histology of matrix, but the chondrocytes showed degenerative changes. After 6 months there was fibrous connective tissue replacement and resorption of the cartilage partially. Stiffness of the cartilage was maintained after 6 months for implanted homologous cartilage grafts.

After the primary procedure, there were slight changes in the chondrocytes following two and eight years and no changes in the matrix histologically.

Hitari conducted a four year study collecting the autologous cartilages during revision surgery and found that chondrocytes which were dead were replaced by the amorphous cartilage material or fibrous tissue".

Tympanic membrane after absorption of gel foam- After 4 weeks



Summary and Conclusions

SUMMARY AND CONCLUSION

1) “For reconstruction of the tympanic membrane, cartilage tympanoplasty is a safe and reliable technique.

2) Tragal cartilage with perichondrium is good material for grafting in reconstructive tympanoplasty.

3) Results are better when reconstruction is performed in dry ear rather than wet ear.

4) Excellent graft take up in cases of myringoplasty and ossiculoplasty.

5) Cartilage can be used in patients with bilateral ear disease, smokers, poor Eustachian tube function, anterior perforations, wet ears and also in revision cases.

6) Results are better when tympanoplasty is performed in dry rather than wet ears”.

7) Our study has shown improvement hearing upto 10-12 dB.

8) “Results obtained are good as the cartilage stabilisation is good due to thinning of the cartilage.

9) Cartilage resists constant negative middle ear pressure and can with withstand long standing Eustachian tube dysfunction. Hence results are good”.

Pitfalls in Study

PITFALLS IN STUDY

1) The sample size is too small to arrive at a definitive conclusion.

2) There is bias among patients who feel improvement in hearing after surgery even though pre and post operative audiogram does not show significant AB closure.

3) Follow up period for taking post operative audiogram is short and long term results needs to be studied and documented.

4) There is no grading system stating the effectiveness of cartilage tympanoplasty.

5) Even though the procedure was done in a single centre, various surgeons did the procedure and also no protocols were followed regarding the surgical procedure depending on the pre operative audiogram, middle ear status, disease, also the surgical approaches were not similar i.e. endaural, post aural approaches were used and endomeatal approach was not used. Also, both microscope was used for the majority of the case and endoscope for few cases.

Annexures

PROFORMA

CASE NUMBER :

NAME :

AGE / SEX :

IP NO. :

DATE OF ADMISSION :

DATE OF DISCHARGE:

OCCUPATION :

INCOME :

ADDRESS :

COMPLAINTS OF :

1. EAR DISCHARGE
2. HARD OF HEARING
3. EAR PAIN
4. RINGING SENSATION
5. FEVER
6. VERTIGO
7. HISTORY OF TRAUMA
8. SYMPTOMS OF INTRACRANIAL COMPLICATIONS
    a. HEADACHE
    b. VOMITING
    c. SEIZURE

PAST HISTORY

HISTORY OF PREVIOUS EAR SURGERY

FAMILY HISTORY

PERSONAL HISTORY

EXAMINATION

EAR

PREAURICULAR REGION

PINNA

POST AURICULAR REGION

EXTERNAL AUDITORY CANAL

TYMPANIC MEMBRANE

MASTOID TENDERNESS

THREE FINGER TEST

FACIAL NERVE

TUNING FORK TEST

RINNE

WEBER

ABSOLUTE BONE CONDUCTION TEST

FISTULA TEST

VESTIBULAR SYSTEM

NOSE

THROAT

DIAGNOSIS

PLAN

INVESTIGATIONS

COMPLETE HEMOGRAM

RENAL FUNCTION TESTS

CHEST X RAY

SEROLOGICAL TESTS

ECG

PURE TONE AUDIOGRAM-PRE AND POST OPERATIVE

IMPEDANCE AUDIOMETRY

X RAY MASTOIDS – LATERAL OBLIQUE VIEW.

HRCT TEMPORAL BONE

MASTER CHART

S. NO	NAME	AGE / SEX	IP NO	DIAGNOSIS	LATERALITY	NAME OF SURGERY	PRE OP HEARING LOSS	POST OP HEARING LOSS
1	RASHI KUMAR	20/M	97350	LEFT COM	UNILATERAL	Type 1 tympanoplasty	35dB	25dB
2	INDUMATHY	21/F	91977	LEFT COM	UNILATERAL	Type 1 tympanoplasty	38dB	30dB
3	SHANTHI	48/F	11675	LEFT COM	UNILATERAL	Type 1 tympanoplasty	30dB	18dB
4	RAJAMMA	30/F	47301	RIGHT COM	UNILATERAL	Type 1 tympanoplasty	40dB	25dB
5	CHANDRA	33/F	41655	LEFT COM	UNILATERAL	Type 1 tympanoplasty	36dB	25dB
6	THAMBACHARI	59/M	41863	LEFT COM WITH PSRP	UNILATERAL	Type 1 tympanoplasty	33dB	20dB
7	MOESH	34/M	35263	BILATERAL COM WITH CP	BILATERAL	Type 1 tympanoplasty	35dB	25dB
8	KAMALA	33/F	40573	CP BILATERAL COM WITH CP	BILATERAL RIGHT EAR	Type 1 tympanoplasty	38dB	29dB
9	JEYASEELAN	59/M	40530	LEFT COM WITH CP	UNILATERAL	Type 1 tympanoplasty	40dB	26dB
10	KEERTHANA	14/F	46880	RIGHT COM WITH CP	UNILATERAL	Type 1 tympanoplasty	35dB	25dB
11	VISHAL	21/M	87606	LEFT COM WITH ATTIC CHOLESTETOMA	UNILATERAL	Inside out mastoidectomy with cartilage tympanoplasty	43dB	45dB
12	CHINNAMMAL	41/F	19644	RIGHT COM WITH ACTIVE MUCOSAL DISEASE	UNILATERAL	Cortical mastoidectomy with Type 1 tympanoplasty	45dB	45dB

S. NO	NAME	AGE / SEX	IP NO	DIAGNOSIS	LATERALITY	NAME OF SURGERY	PRE OP HEARING LOSS	POST OP HEARING LOSS
13	VIMALA	37/F	125465	LEFT COM	UNILATERAL	Type 1 tympanoplasty	33dB	20dB
14	PRAKASH	29/M	113603	BILATERAL COM WITH PSRP	UNILATERAL	Left atticotomy with Cartilage tympanoplasty	30dB	30dB
15	THIRUMOORTHY	24/M	108095	BILATERAL COM	BILATERAL	Right cortical mastoidectomy with type 1 tympanoplasty	36dB	25dB
16	GANESH	26/M	48664	LEFT COM WITH ATTIC CHOL	UNILATERAL	Inside out mastoidectomy with cartilage tympanoplasty	30dB	25dB
17	BALAMURUGAN	50/M	49936	RIGHT COM	UNILATERAL	Type 1 tympanoplasty	35dB	20dB
18	RAJIV GANDHI	26/M	43152	LEFT COM	UNILATERAL	Type 1 tympanoplasty	40dB	27dB
19	MADURAI	35/M	28910	LEFT COM	UNILATERAL	Type 1 tympanoplasty	43dB	30dB
20	INDIRA	40/F	23465	BILATERAL COM	BILATERAL	Cortical mastoidectomy with Type 3 tympanoplasty	33dB	20dB
21	PAIYALAL	27/M	18498	LEFT COM	UNILATERAL	Type 1 tympanoplasty	35dB	22dB
22	EAGAVALLI	30/F	4516	BILATERAL COM	BILATERAL	Type 1 tympanoplasty	38dB	30dB
23	KUMARI	33/F	1239	LEFT COM	UNILATERAL	Type 1 tympanoplasty	35dB	40dB
24	JAYALAKSHMI	15/F	1426	LEFT COM	UNILATERAL	Type 1 tympanoplasty	40dB	30dB
25	KUMAR	25/M	304181	RIGHT COM	UNILATERAL	Type 1 tympanoplasty	30dB	21dB
26	SIVA	34/M	17539	RIGHT COM	UNILATERAL	Type 1 tympanoplasty	32dB	20dB

S. NO	NAME	AGE / SEX	IP NO	DIAGNOSIS	LATERALITY	NAME OF SURGERY	PRE OP HEARING LOSS	POST OP HEARING LOSS
27	SURIYA	15/M	10281	LEFT COM	UNILATERAL	Type 1 tympanoplasty	37dB	25dB
28	MUNUSWAMY	25/M	28216	RIGHT COM	UNILATERAL	Type 1 tympanoplasty	43dB	30dB
29	SIVAGAMY	66/F	71483	BILATERAL COM	BILATERAL	Type 1 tympanoplasty	55dB	41dB
30	ANDAL	57/F	76207	BILATERAL COM	BILATERAL	Type 1 tympanoplasty	58dB	60dB
31	ARUL	35/M	92097	BILATERAL COM	BILATERAL	Type 1 tympanoplasty right	55dB	48dB
32	SUGANTHY	13/F	88580	LEFT COM	UNILATERAL	TYPE 2 TYMPANOPLASTY	35dB	38dB
33	JOHNSON	20/M	85902	RIGHT COM	UNILATERAL	Cortical mastoidectomy with Type 1 tympanoplasty	40dB	30dB
34	SANGEETHA	24/F	81243	RIGHT COM	UNILATERAL	Revision intact canal wall mastoidectomy with type 3 tympanoplasty	50dB	56dB
35	KUMAR	38/M	93007	LEFT COM	UNILATERAL	Type 1 tympanoplasty	54dB	57dB

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI-3

EC Reg No.ECR/270/Inst./TN/2013
Telephone No. 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr.Lourdes Albina. S.A.
Postgraduate M.S.(ENT)
Madras Medical College
Chennai 600 003

Dear Dr.Lourdes Albina. S.A.

The Institutional Ethics Committee has considered your request and approved your study titled **"Cartilage Tympanoplasty – A review on its postoperative / Functional outcomes on hearing" No.23022015.**

The following members of Ethics Committee were present in the meeting held on 03.02.2015 conducted at Madras Medical College, Chennai-3.

1.	Dr.C.Rajendran, M.D.,	: Chairperson
2.	Dr.R.Vimala, M.D., Dean, MMC, Ch-3	: Deputy Chairperson
3.	Prof.B.Kalaiselvi, M.D., Vice-Principal, MMC, Ch-3	: Member Secretary
4.	Prof.R.Nandini, M.D., Inst.of Pharmacology, MMC	: Member
5.	Prof.P.Ragumani, M.S., Professor, Inst.of Surgery, MMC	: Member
6.	Prof.Md.Ali, M.D., D.M., Prof. & HOD of Medl.G.E., MMC	: Member
7.	Prof.K.Ramadevi, Director, Inst.of Biochemistry, MMC	: Member
8.	Prof.Saraswathy, M.D., Director, Pathology, MMC, Ch-3	: Member
9.	Prof.S.G.Sivachidambaram, M.D.,Director i/c Institute of Internal Medicine, MMC, Ch-3	: Member
10.	Thiru S.Rameshkumar	: Lay Person
11.	Thiru S.Govindasamy, B.A., B.L.,	: Lawyer
12.	Tmt.Arnold Saulina, M.A., MSW.,	: Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

4/2/15

Member Secretary, Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
CHENNAI-600 003

INFORMATION TO PARTICIPANTS

TITLE : **"CARTILAGE TYMPANOPLASTY – A REVIEW ON ITS POSTOPERATIVE / FUNCTIONAL OUTCOMES ON HEARING"|**

INVESTIGATOR : **DR. LOURDES ALBINA .S.A,**
MS ENT Post-Graduate,
Madras Medical College, Chennai.

GUIDE **: PROF. Dr.M.K.RAJASEKAR, M.S.,D.L.O.,**
Professor of ENT,
Upgraded Institute of Otorhinolaryngology,
Madras Medical College,
Rajiv Gandhi Govt. General Hospital,
Chennai – 600003

CHIEF CO-ORDINATOR :
Dr. MUTHUKUMAR, MS., DLO.,
The Director i/c and Professor,
Upgraded Institute of Otorhinolaryngology,
Madras Medical College,
Rajiv Gandhi Govt. General Hospital,
Chennai – 600003

Name of the Participant: _____

Site :

You are invited to take part in this research / study / procedures / tests. The information is this document is meant to help you whether or not to take part. Please feel free to ask if you have any queries or concerns.

What is the purpose of research?

The repair of tympanic membrane perforation can be made with tragal cartilage either with endoscopic or microscopic approach. We want to test the efficacy and success rate of a new _____ (drug / intervention / surgery / procedure / lab test) in this disease / condition.

The study design : Retrospective and Prospective Study

Study Procedure:

The study involves size of perforation and ossicular status for which we will need physical examination, audiological evaluation, examination on table, CT-Temporal bone – axial coronal cuts and or MRI.

The planned schedule involve visits at _____, _____, _____ and _____ days / weeks after your initial visit. You will be required to visit the hospital _____ number of times during the study.

At each visit the study physician will examine you. Some audiological or clinical examination will be carried out at each visit if needed. These tests are essential to monitor your condition and the safety and efficacy of treatment given to you. In addition if you notice any hearing changes. You must contact the persons listed at the end of the document.

You may have to come to the hospital (study site) for examination and investigations apart from your scheduled visits, if required.

Possible risks to you – If any briefly mention.

Possible benefits to you – If any briefly mention.

Possible benefits to other people

The results of the research may provide benefits to the society in terms of advancement of medical knowledge and / or therapeutic benefit to future patients.

Confidentiality of the information obtained from you

You have the right to confidentiality regarding the privacy of your medical information (personal details, results of physical examinations, investigations and your medical history). By signing the document you will be allowing the research team investigators other study personnel, sponsors, Institutional Ethical Committee and any person or agency required by law like the Drug Controller General of India to view your data if required.

The information of this study if published in scientific journals or presented at scientific meetings will not reveal your identity.

How will your decision not to participate in the study affect you?

Your decision not to participate in this research study will not affect your medical care or your relationship with the investigator or the institution. You will be taken care of and you will not loose any benefits to which you are entitled.

Can you decide to stop participating in the study once you start?

The participation in this research is purely voluntary and you have the right to withdraw from the study at any time during the course of the study without giving any reasons. However, it is advisable to talk to the research team prior to stopping the treatment / discontinuing the procedures etc.

Signature of Investigator

Signature of Participant

Date

Date

INFORMED CONSENT FORM

Title of the study - **"CARTILAGE TYMPANOPLASTY – A REVIEW ON ITS POSTOPERATIVE/FUNCTIONAL OUTCOMES ON HEARING"|**

Name of the participant:

Name of the Principal / co-investigator:

Name of the Institution : Upgraded Institute of Otorhinolaryngology,
Madras Medical college and
Rajiv Gandhi Govt. General Hospital, Chennai.

I _____ (name of the participant), have read the information in this form (or it has been read to me). I am free to ask any question and they will be answered. I am over 18 years of age and exercising my free power of choice, hereby give my consent to be included as a participant in _____ (**"CARTILAGE TYMPANOPLASTY – A REVIEW ON ITS POSTOPERATIVE/FUNCTIONAL OUTCOMES ON HEARING"**)

1) I have read and understood this consent form and the information provided to me.
2) I have had the consent document explained to me.
3) I have been explained about the nature of the study.
4) I have been explained about the rights and responsibilities by the Investigator.
5) I have informed the investigator of all the treatments I am taking or have been in the past _____ months including my native (alternative) treatments.
6) I have been advised about the risks associated with my participation in the study.
7) I agree to cooperate with the investigator and I will inform him/her immediately if I suffer unusual symptoms.
8) I have not participated in any research study within the past _____ months.
9) I have not donated blood within the past _____ months.
10) I am aware of the fact that I can opt out of the study at any time without having to give any reason and this will not affect my future treatment in the hospital.
11) I am also aware that the investigators may terminate my participation in the study at any time, for any reason, without any consent.
12) I hereby give permission to the investigators to release the information obtained from me as result of participation in the study to the sponsors, regulatory authorities, Government agencies and ethical committee. I understand that they may inspect my original records.
13) I understand that my identity will be kept confidential if my data is publically presented.
14) I have had my questions answered to my satisfaction.
15) I consent voluntarily to participate as a participant in the study research.

I am aware, that if any questions during this study, I should contact the investigators. By signing this consent form, I attest that the information given in this document has been clearly explained to me and understood by me. I will be given a copy of this consent document.

For adult participants:

Name and signature / thumb impression of the participant (or legal representative if participant incompetent):

Name_____ Signature _____ Date _____

Name and signature of impartial witness (required for illiterate patients):

Name_____ Signature _____ Date _____

Name and signature of the investigator or his representative obtaining consent:

Name_____ Signature _____ Date _____

ஆராய்ச்சி தகவல் தாள்

சென்னை இராஜீவ் காந்தி அரசு பொது மருத்துவமனைக்கு காது, மூக்கு, தொண்டை பிரிவிற்கு வரும் நோயாளிகளில் காதில் செவித்ததிறையில் ஓட்டை ஏற்பட்டு சீழ் வடிபவர்களுக்கு காதின் குருத்தெலும்பை வைத்து அறுவை சிகிச்சை மேற்கொள்ளப்படும் போது அறுவை சிகிச்சைக்குப் பிறகு காதின் கேட்கும் திறனில் முன்னேற்றம் ஏற்பட்டுள்ளதா என்பதைப் பற்றிய ஆய்வு.

காதின் நடுப்பகுதியில் தொற்று ஏற்பட்டு (Middle ear infection due to chronic suppurative otitis media) செவித்திறையில் ஓட்டை மற்றும் காதினுள் உள்ள எலும்புகள் (Ossicles) பாதிக்கப்படுகிறது. இதனால் நோயாளிகளின் செவித்திறன் பாதிக்கப்படுகிறது. அறுவை சிகிச்சை செய்யப்படுவதால் காதில் சீழ் வடிவதை நிறுத்த முடியும். மேலும் காதில் கேட்கும் திறன் எவ்வாறு முன்னேற்றம் கண்டுள்ளது என்பதைப் பற்றிய ஆராய்ச்சியாகும்.

நீங்கள் இந்த ஆராய்ச்சியில் பங்கேற்க நாங்கள் விரும்புகிறோம்.

இந்த ஆராய்ச்சியின் முடிவுகளை அல்லது கருத்துக்களை வெளியிடும் போதோ அல்லது ஆராய்ச்சியின் போதோ தங்களது பெயரையோ அல்லது அடையாளங்களையோ வெளியிடமாட்டோம் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

இந்த ஆராய்ச்சியில் பங்கேற்பது தங்களுடைய விருப்பத்தின் பேரில் தான் இருக்கிறது. மேலும் நீங்கள் எந்நேரமும் இந்த ஆராய்ச்சியிலிருந்து பின் வாங்கலாம் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

இந்த ஆராய்ச்சியின் முடிவுகளை ஆராய்ச்சியின் போது அல்லது ஆராய்ச்சியின் முடிவின் போது தங்களுக்கு அறிவிக்கப்படும் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

ஆராய்ச்சியாளர் கையொப்பம் பங்கேற்பாளர் கையொப்பம்

தேதி :

சுய ஒப்புதல் படிவம்

ஆய்வு செய்யப்படும் தலைப்பு :

காதின் குருத்தெலும்பை வைத்து அறுவை சிகிச்சை மேற்கொள்ளப்படும் போது அறுவை சிகிச்சைக்குப் பிறகு காதின் கேட்கும் திறனில் முன்னேற்றம் ஏற்பட்டுள்ளதா என்பதைப் பற்றிய ஆய்வு.

ஆராய்ச்சியாளர் பெயர் : இராஜீவ் காந்தி அரசு பொது மருத்துவமனை மற்றும்
சென்னை மருத்துவக் கல்லூரி,
சென்னை - 600 003.

பங்கு பெறுபவரின் பெயர் : உறவுமுறை :
பங்கு பெறுபவரின் எண். :

பங்கு பெறுபவர் இதனை (✓) குறிக்கவும்

மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களைப் பெறவும் வாய்ப்பளிக்கப்பட்டது.	☐
நான் இவ்ஆய்வில் தன்னிச்சையாகத்தான் பங்கேற்கிறேன். எந்தக் காரணத்தினாலோ எந்தக் கட்டத்திலும் எந்த சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்ஆய்வில் இருந்து விலகிக் கொள்ளலாம் என்றும் அறிந்து கொண்டேன்.	☐
இந்த ஆய்வு சம்மந்தமாகவோ, இதை சார்ந்த மேலும் ஆய்வு மேற்கொள்ளும்போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளைப் பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். நான் ஆய்வில் இருந்து விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன்.	☐
இந்த ஆய்வின் மூலம் கிடைக்கும் தகவல்களையும், பரிசோதனை முடிவுகளையும் மற்றும் சிகிச்சை தொடர்பான தகவல்களையும் மருத்துவர் மேற்கொள்ளும் ஆய்வில் பயன்படுத்திக் கொள்ளவும் அதைப் பிரசுரிக்கவும் என் முழு மனதுடன் சம்மதிக்கிறேன்.	☐
இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக்கொள்கிறேன். எனக்குக் கொடுக்கப்பட்ட அறிவுரைகளின்படி நடந்து கொள்வதுடன், இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதியளிக்கிறேன். என் உடல் நலம் பாதிக்கப்பட்டாலோ அல்லாத எதிர்பாராத வழக்கத்திற்கு நோய்க்குறி தென்பட்டாலோ உடனே அதை மருத்துவ அணியிடம் தெரிவிப்பேன் என உறுதி அளிக்கிறேன்.	☐
இந்த ஆய்வில் எனக்கு மருத்துவப் பரிசோதனை, செவித்திறன் ஆய்வு, அறுவை சிகிச்சை மற்றும் CT ஸ்கேன், MRI பரிசோதனைகள் செய்து கொள்ள நான் முழு மனதுடன் சம்மதிக்கிறேன்.	☐

பங்கேற்பவரின் கையொப்பம்..... இடம்..... தேதி
கட்டைவிரல் ரேகை

பங்கேற்பவரின் பெயர் மற்றும் விலாசம்.....

ஆய்வாளரின் கையொப்பம்..... இடம்..... தேதி

ஆய்வாளரின் பெயர்.....

(இந்த ஆராய்ச்சியின் முடிவுகளை அல்லது கருத்துக்களை வெளியிடும் போதோ அல்லது ஆராய்ச்சியின் போதோ தங்களது பெயரையோ அல்லது அடையாளங்களையோ வெளியிட மாட்டோம் என்பதையும் தெரிவித்துக்கொள்கிறோம்.)

BIBILIOGRAPHY

1. Duckert LG, Muller J, Makielski KH, Helms J.Composite autograft "shield" reconstruction of remnant tympanic membranes. Am J Otol 1995; 16:21- 26.

2. Yung M. Cartilage tympanoplasty: literature review. J Laryngol Otol. 2008; 122(7): 663- 672.

3. Poe DS, Gadre AK. Cartilage tympanoplasty fo management of retraction pockets and cholesteatomas. Laryngoscope 1993; 103: 614- 618.

4. Yamamoto E, Iwanaga M, Fukumoto M. Histologic study of homograft cartilage implanted in the middle ear. Otolaryngol Head Neck Surg 1988; 98: 546-551.

5. Hamed M, Samir M, El Bigermy M. Fate of cartilage material used in middle ear surgery light and electron microscopy study. Auris Nasus Larynx 1999; 26: 257- 262.

6. Dornhoffer JL. Hearing results with cartilage tympanoplasty. Laryngoscope 1997; 107: 1094-1099.

7. Gerber MJ, Mason JC, Lambert PR. Hearing results after primary cartilage tympanoplasty. Laryngoscope 2000; 110: 1994-1999.

8. Heermann J. Autograft tragal and conchal palisad cartilage and perichondrium in tympanomastoid reconstruction. Ear Nose Throat J 1992; 71: 344-349.

9. Dornhoffer JL. Cartilage tympanoplasty: indications, techniques, and outcomes in a 1000- patient series. Laryngoscope. 2003; 113(11): 1844-1856.

10. Gerard JM, Decat M, Gersdorff M. Tragal cartilage in tympanic membrane reconstruction. Acta Otorhinolaryngol Belg. 2003; 57(2): 147-150

11. Levinson RM. Cartilge-perichondrial composite graft tympanoplasty in the treatment of posterior marginal and attic retraction pockets. Laryngoscope.1987; 97(9): 1069-1074

12. Dornhoffer JL. Cartilage Tympanoplasty. Otolaryngol Clin North Am. 2006; 39(6): 1161-1176.

13. Sheehy JL, Anderson RG. Myringoplasty. A review of 472 cases. Ann Otol Rhinol Laryngol 1980; 89: 331-334.

14. Amedee RG, Mann WJ, Riechelmann H. Cartilage palisade tympanoplasty. Am J Otol 1989; 10: 447-450

15. Buckingham RA. Fascia and perichondrium atrophy in tympanoplasty and recurrent middle ear atelectasis. Ann Otol Rhinol Laryngol 1992; 101: 755-758.

16. Anisur Rahman. Healing of tympanic membrane perforation: an experimental study by. From Karolinska Institute and University Hospital Stockhole Sweden 2007, ISBN 978-91-7357-243-9.

17. Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology.

18. Standard classification for surgery of chronic ear infection. Arch Otolaryngol Head Neck Surg 1964;81:204-5

19. Berthold E. Uber Myringoplastic. Med-chir centralb. 1879; 14: 195-207

20. Goodhill V. Articulated polyethylene prosthesis with perichondrial graft in stapedectomy. Rev Laryngol(Bordeaux) 1951;82:305_32.

21. Linde RE. The cartilage-perichondrium graft in the treatment of posterior tympanic membrane retraction pockets. Laryngoscope 1973;83:747–53

22. Tabb HG. Closure of perforations of the tympanic membrane by vein grafts: a preliminary report of 20cases. Laryngoscope 1960;70:271_286.

23. Storrs L. Myringoplasty with the use of Fascia Grafts. Arch Otolaryngol 1961; 74:45-49.

24. Yetiser S, Tosun F, Satar B. Revision myringoplasty with solvent dehydrated human dura mater: Otolaryngol Head Neck Surg. 2001 May; 124(5):518-21.

25. Heermann J, Heermann H, Kopstein E. Fascia and cartilage palisade tympanoplasty. Arch Otolaryngol 1970;91:228–41.

26. Couloigner V, Baculard F, El Bakkouri W, Viala P, Francois M, Narcy P et al. Inlay butterfly cartilage tympanoplasty in children. Otol Neurotol 2005;26:247 –51

27. Adkins WY. Composite autograft for tympanoplasty and tympanomastoid surgery. Laryngoscope 1990;100:244–7

28. Anderson J, Caye-Thomasen P, Tos M. A comparison of cartilage palisades and fascia in tympanoplasty after surgery for sinus or tensa retraction cholesteatoma in children. Otol Neurotol 2004;25:856–63

29. Gierek T, Slaska-Kaspera A, Majzel K, Klimczak-Gotqbm L. Results of myringoplasty and type I tympanoplasty with the use of fascia, cartilage and perichondrium grafts [in Polish]. Otolaryngologia Polska 2004;3:529–33

30. M YUNG Cartilage tympanoplasty: literature review. The Journal of Laryngology & Otology (2008), 122, 663–672. # 2008 JLO (1984) Limiteddoi:10.1017/S0022215108001813

31. Ayache D, Zaki Z, Wiener V. Williams MT. Delayed luxation of the stapes into the vestibule after cartilage tympanoplasty. Otol Neurotol 2006;27:901-2

32. Ghanem MA, Monroy A, Alizadeh FS, Nicolau Y, Eavey RD. Butterfly cartilage graft inlay tympanoplasty for large perforations. Laryngoscope 2006;116:1813–16

33. Banzer, M. (1640) Disputatio de auditione laesa (Disertation on deafness)

34. Yearsley J. Deafness practically illustrated. London: Churchill & Sons; 1863.

35. Toynbee J. On the use of an artificial membrana tympani in cases of deafness dependent upon perforations or destruction of the natural organ. London: J. Churchill & Sons; 1853.

36. Roosa DB. Diseases of the ear. New York: William Wood & Co.; 1876.

37. Blake CJ. Transactions of the First Congress of the International Otological Society. New York: D. Appleton & Co; 1887.

38. Zollner F. The principles of plastic surgery of the sound-conducting apparatus. J Laryngol Otol 1955;69:637.

39. Joynt JA. Repair of drum. Iowa Med Soc 1919;9:51.

40. Derlacki EL. Repair of central perforations of tympanic membrane. Arch Otolaryngol 1953;58:405.

41. Wullstein H. Funktionelle Operationen im Mittelohr mit Hilfe des freien Spalt-lappen-Transplantates. Arch Ohren-Nasen-u Kehlkopfh 1952;161:422.

42. Zollner F. Panel of myringoplasty. Second workshop on reconstructive middle ear surgery. Arch Otol 1963;78:301.

43. Heermann H. Tympanic membrane plastic with temporal fascia. Hals-Nasen-Ohrenh 1960;9:136.

44. Shea JJ. Vein graft closure of eardrum perforations. J Laryngol Otol 1960;74:358

45. Glasscock ME, House WF, Graham M. Homograft transplants to the middle ear. A follow-up report. Laryngoscope 1972;82: 868.

46. MacKinnon DM. Homograft tympanic membrane in myringoplasty. Ann Otol Rhinol Laryngol 1972;81:194–202.

47. Overbosch HC. Homograft myringoplasty with micro-sliced septal cartilage. Pract Otorhinolaryngol 1971;33:356–7

48. Brandow EC Jr. Homograft tympanic membrane transplant in myringoplasty. Trans Am Acad Ophthalmol Otolaryngol 1969;73:825–35.

49. Packer P, Mackendrick A, Solar M. What's best in myringoplasty:underly or overlay, dura or fascia? J Laryngol Otol1982;96:25–41

50. Zakzouk S, Attallah M. Transcanal tympanoplasty: dura versus temporalis fascia. Ear Nose Throat J 1992;71:590–2

51. Sunil S Nichlani et al. Reconstruction of the Tympanic Membrane with Partial Tragal cartilage Graft Versus Temporalis Fascia Graft. Bombay Hospital Journal,vol.52,No.2, 2010

52. Heermann J. Auricular cartilage palisade tympano-,epitympano-,antrum- and mastoid-plasties. Clin Otolaryngol 1978;3:443–6

53. Milewski C. Composite graft tympanoplasty in the treatment of ears with advanced middle ear pathology. Laryngoscope 1993;103:1352–655. Overbosch HC. Homograft myringoplasty with microsliced septal cartilage. Practica Oto-Rhino-Laryngologica 1971;33:356–7

54. Hyden D.: Ear drum perforations in children after ventilation tube treatment.: Int J Pediatr Otorhinolaryngol 1994;29:93–100.

55. Murbe D, Zahnert T, Bornitz M, Huttenbrink KB. Acoustic properties of different cartilage reconstruction techniques of the tympanic membrane. Laryngoscope 2002; 112:1769–76

56. Spielmann P, Mills R. Surgical management of retraction pockets of the pars tensa with cartilage and perichondrial grafts. J Laryngol Otol 2006;120:725–9

57. Shin S-H, Lee W-S, Kim H-N, Lee H-K. Wheel-shaped cartilage-perichondrium composite graft for the prevention of retraction pocket development. Acta Otolaryngol (Stockh) 2007;127:25–8

58. Eavey RD. Inlay tympanoplasty: cartilage butterfly technique. Laryngoscope 1998;108:657–61

59. Hartwein J, Leuwer RM, Kehrl W. The total reconstruction of the tympanic membrane by the “crowncork” technique. Am J Otolaryngol 1992;13:172–5

60. Neumann A, Jahnke K. Tympanic membrane reconstruction using cartilage – indications, techniques and results [in German]. HNO 2005;53:573–84

61. Zahnert T, Huttenbrink K-B, Murbe D, Bornitz M. Experimental investigations of the use of cartilage in tympanic membrane reconstruction. Am J Otology 2000;21: 322–8

62. Mirko Tos.:Cartilage Tympanoplasty: Classifications of methods—techniques--Results :Edition I, Thieme,2009

63. Glasscock-Shambaugh, Surgery of the ear- Fifth edition

64. Harold Ludman and Tony Wright, Diseases of the ear-Sixth edition.